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ERRATA.

Page 27, line 13, for "Jack, R. V." read "Jack, R. W."
,, 94, 5 lines from end, for "*R. P. Wood*" read "*R. C. Wood*"
,, 97, line 17, delete sp. n.
,, 103, line 18, delete sp. n.
,, 104, lines 1 and 11, delete sp. n.
,, 104, 2 lines from end, for "**Haplolopha**" read "**Hoplolopha**"
,, 110, line 10, for "*Macfree*" read "*Macfie*"
,, 111, line 28, delete gen. nov.
,, 115, 7 lines from end, delete sp. nov.
,, 115, 3 lines from end, for "Bezzi" read "Coquillet"
,, 178 (note), for "Dr. P. H. Manson-Bahr" read "F. W. O'Connor"
,, 258, 14 lines from end, for "*Lophophoceratomyia*" read "*Lophoceratomyia*"
,, 260, line 20, for "van Ecke" read "van Eecke"
,, 261, line 29, for "*Ochlerätotus*" read "*Ochlerotatus*"
,, 262, line 1, for "**Lepisthauma**" read "**Lepiothauma**"
,, 301, lines 7 and 8, for "comb" read "pecten"
,, 336, line 11, for "(p. 000)" read "(p. 320)"

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BULLETIN

OF

ENTOMOLOGICAL RESEARCH.

VOL. XV. 1924.

SECOND REPORT OF THE TSETSE-FLY INVESTIGATION IN THE NORTHERN PROVINCES OF NIGERIA.

By

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and

H. MORRISON, M.A., M.D. (Cantab.).

(MAP.)

I. Introduction.

The following report covers the entomological work of the Tsetse Investigation from December 1922 to January 1924. The original investigators were joined by Dr. W. A. Young in July 1923, and he remained till December of the same year, when he left to take up an appointment in the Gold Coast Colony. His place was taken by Dr. H. Morrison. Owing to the exigencies of leave only a solitary investigator was at work during seven months of the period. Apart from the work detailed here a considerable amount of treatment of sleeping sickness with Bayer 205 has been carried out, and an account of this will be given in a more appropriate place. The thanks of the investigators are due to Capt. R. O. Ramage and to Lt. P. W. D. Thurley, the Political Officers at Azare. These Officers have assisted the Investigation in many ways. The Director of the Survey School at Kano kindly provided us with a trained native upon whose survey of Sherifuri the accompanying map is based. We wish also to express our gratitude again to His Excellency Sir Hugh Clifford, G.C.M.G., Governor of Nigeria, for his constant support and encouragement.

The report concerns mainly the results obtained by the regular dissection of *G. morsitans* and *G. tachinoides* collected at various fixed points in an area around the village of Sherifuri, which lies about a hundred miles due east of Kano and twenty-five miles north of Azare. The area is bounded to the south by the Jamaari River and

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to the north by the Kiyawa River and is traversed by high sand ridges running east and west, with alternating stretches of low-lying black mud which is largely inundated in the height of the rains. An important road joining Azare and Hadeija crosses the area.

The Jamaari River, called hereafter the "main river," is a sandy stream bed some 200 to 300 yards in width. Water flows in it for about six months of the year and for the remaining time lies in pools. Its bed is clearly moving to the south-east and the south bank is steep and heavily forested to its edge. The north bank, where the movement is taking place, is low and bounds a long-grass plain with isolated trees, and this stretches to the old bed of the river, which can still be traced, and is, indeed, a stream in the height of the rains. The original bank is steep and bordered by heavy forest similar to that which borders the present banks where these have not moved. The maximum movement has been about one and a half miles. Parallel with the old channel is a meandering shallow stream bed, known as the Malele River, which debouches into the main river at both ends and also acts as a short cut in the floods. In the deeper parts of these channels and in several other depressions of the plain, water remains for the greater part of the year as stagnant pools. The vegetation about these pools is as follows. Growing in the water is much mimosa, and at its edge is a line of giyeya (*Mitragyne africana*), large-timbered semi-prone evergreen trees. On the bank is a dense thorn entanglement which becomes very dry and almost shadeless at the end of the dry season. This may stretch for some distance from the top of the bank and generally changes into a zone of heavy timbered forest with very long grass, and this is never entirely shadeless, though most of the trees are deciduous. Beyond this zone is the black mud plain proper, on which the grass grows to a height of about two feet and withers and is burnt within a month of the cessation of the rains. It is forested by abundant baobab and thorn trees with small patches of thorn entanglement and has very scanty shade for three or four months of the year. The sand ridges are mainly farmed, but where the land has been allowed to revert there are indications that the normal forest is an open long-grassed wood of moderate-sized, mainly deciduous trees, among which predominate the red silk cotton (*Bombax buonopozense*) and the desert date (*Balanites aegyptiaca*).

The Kiyawa River, here some eight miles north of the main river, which it slowly approaches and joins at Sokwa, twenty miles to the north-east, is of an entirely different type from the main stream. It flows in a deep mud bed with little indication of recent meandering and is almost a permanent stream. Its channel is twenty to thirty yards across and in the bed are numerous malmo trees (*Eugenia owariensis*), which give the impression of a thin mangrove swamp. The thorn entanglement of its banks is narrow and discontinuous, and the stream flows through long-grass country with isolated shade-trees. Its neighbourhood is or has been largely farmed, but sleeping sickness has seriously depleted the population, not only near Sherifuri but also at other points in its course of 150 miles.

II. Climate.

The climate is dry. The meteorological records of 1923 are given in Table I. This year was a particularly wet one, the rainfall totalling 36 inches as against a normal fall of 25 inches, and the rivers rising to a height unknown by the natives for thirty years. The rains normally break in April and cease in September, August being the wettest month. The dry harmattan wind blows more or less continuously from the beginning of December to the end of March, and dense haze is not uncommon. The grass is burnt in the baobab bush about October, on the sand ridges and in the heavy forest at varying times during the next three months, and on the plain by the main river and the Kiyawa River in March. In general, early and incomplete grass burning is the custom.

TABLE I.

Meteorological Records at Sherifuri Camp, 1923.

Month.	Temperatures. Mean.	Absolute maximum.	Absolute minimum.	Relative humidity.	Rainfall in inches.	Remarks.
1923						
January..	71·7	91	51	—	0	Continuous harmattan
February	73·4	93	52	—	0	,, ,,
March ..	82·6	101	58	—	0	,, ,,
April ..	87·8	104	71	—	0·13	
May ..	88·5	101	70	61	1·65	
June ..	84·0	96	71	85	5·35	
July ..	78·3	87	68	89	6·75	
August ..	76·8	87	68	84	18·58	
September	79·5	90	71	75	3·91	
October ..	80·6	93	66	64	0·18	Intermittent harmattan
November	76·2	94	59	39	0	Continuous harmattan
December	72·2	90	56	37	0	,, ,,
1924						
January..	71·0	89	49	39	0	,, ,,

Total rainfall for year=36·37 inches.
The above are laboratory readings.

III. Fauna and Population.

The natives are Kanuri. They are a farming people and live in a poor type of village built entirely of grass. The main villages are permanent and the same land is farmed for many years. The population is estimated at 36 to the square mile in the Gadau district in which Sherifuri is located.

The domesticated animals consist of numerous goats and sheep, while a little to the west on the ridge there are large flocks of the latter. There are no cattle between the rivers and practically no horses, though these are often brought through on the main road. Donkeys are numerous and are taken a good deal into the bush by such people as charcoal-burners. Dogs are fairly numerous.

There is a small herd of three buffalo, which keep to the neighbourhood of the main river for most of the year but during the later rains wander through the area. The large antelope consist of roan, Senegal hartebeests and the defassa waterbuck. These are little in evidence in the dry season, but in the early rains they come into the area in some numbers, especially that part of the low country west of the main road. At other times they move about on the river plain but are not numerous. Reedbuck are present near the main river and in the rains move across to the edge of the sand ridges. Bushbuck are found in the neighbourhood of the pools. The grey duiker occurs chiefly on and about the ridges and in the long-grass areas. The red-fronted gazelle is found in the open bush at all times of the year, and the warthog is common everywhere through the year except on the ridges and about the Kiyawa River. From the point of view of a big game hunter it would be considered a very poor area, as in spite of this long list of animals only the warthog is really numerous.

Lions occasionally visit the area, and in 1923 one remained for several months. No sign of leopards has been seen, and hyaenas are very scarce. Jackals and smaller Carnivora are common. Baboons are absent, but there are large troops of monkeys which especially haunt the neighbourhood of the pools.

Of the larger birds the ground hornbill is common and the guineafowl is exceedingly numerous, many hundreds being seen often in a mile of country. Pelicans, various storks and herons abound, and at certain times several species of goose and duck are common. There is an exceedingly rich fauna of the smaller birds.

Crocodiles occur at secluded spots in the main river, at certain times in the Kiyawa River, and in a deep pool in the old river bed ; they are not numerous. The land *Varanus* (*V. exanthematicus*) is very common ; a request for these animals resulted in 65 being brought to the camp in one month ; they occur mainly on the banks of the pools and often plunge into the water. The water *Varanus* (*V. niloticus*) is also common and spends the daytime in the water or basking in trees overhanging the pool, while at night it remains in burrows ; it grows to a length of about six feet and is much feared by the natives as it lashes with its serrated tail and causes severe wounds thereby. Several species of land and water tortoises occur. Snakes are not much in evidence.

IV. Location of Tsetse-flies.

This is an arm of a large tsetse area which lies to the east about Katagum, and it runs as a long wedge into important cattle country. As is so common in Northern Nigeria the fly-belt cuts the cattle off from the surface water and the best dry season grazing.

In the dry season *Glossina tachinoides* is found only in the neighbourhood of water, and as the pools dry up the fly leaves them. Very few indeed at this time come on to the sand ridges, and at the end of the dry season they are almost confined to the neighbourhood of the two rivers and the old river bed. In the evening especially they range the baobab bush in the neighbourhood of these. They spread from these foci soon after the rains begin and reach their full extent in the third month of the wet season. As usual, *G. morsitans* ranges more widely than the riverine species, but it also comes little on to the ridges. It remains about the forest pools after *G. tachinoides* has left, and these as well as the neighbourhood of the more permanent water form its dry season foci. It is, however, at all seasons very scarce and very localised near the Kiyawa River. Certain points which come out in the study of the trypanosome infections of the flies show that they keep fairly definitely to their several foci in the dry season. No other species of tsetse-fly occurs in this part of the country, though *G. palpalis* infests both rivers nearer their source.

V. Food and Breeding.

The estimation of the food of the flies by measurement of blood cells found in their guts was made during six months, including the last month of the dry season and the whole of the rains. Classification of the recognisable blood as mammalian or non-mammalian has been done for a further four months. A standard scale of the size of the red blood cells was made by measuring these in a variety of animals and classing them into groups according to differences of one micron in diameter. No such grouping can, of course, be entirely satisfactory, as the blood of small mammals falls inconveniently into all the mammal groups and important animals such as the donkey and the warthog fall into one group. All the antelope, however, come into two of the groups, and the method suffices, so far as we have tested it, to distinguish the blood of birds from that of reptiles and amphibia. The scale obtained is shown in Table II, the first column containing a list of the animals whose blood was measured. Bloods which showed little sign of change encountered in the flies were measured in the same manner, ten cells being drawn and measured in each case. The finding in *G. tachinoides* is shown in the third column and that in *G. morsitans* in the fourth column. Diagram I shows the variations in a graphic manner. The table shows that during this time *tachinoides* drew about 22 per cent. of its food from the antelope groups, while *morsitans* drew about 74 per cent. of its food from this source. They drew approximately the same amount from the donkey-warthog group, but there is a striking difference in the man-monkey group, *tachinoides* taking more than four times as large a proportion of

food from this group as *morsitans* does. The trypanosome infections of the proboscides bear a striking relation to the amount of blood taken from the antelope. Thus over a period of 13 months in 11,500 *tachinoides* there were 911 (7·9 per cent.) infections of the proboscis as against 1,775 (28·1 per cent.) in 6,314 *morsitans*. This point was brought out in our first report and is now confirmed by more accurate methods (1).

TABLE II.

Analysis of the Food Supply of Glossina tachinoides *and* G. morsitans *during the Wet Season at Sherifuri.*

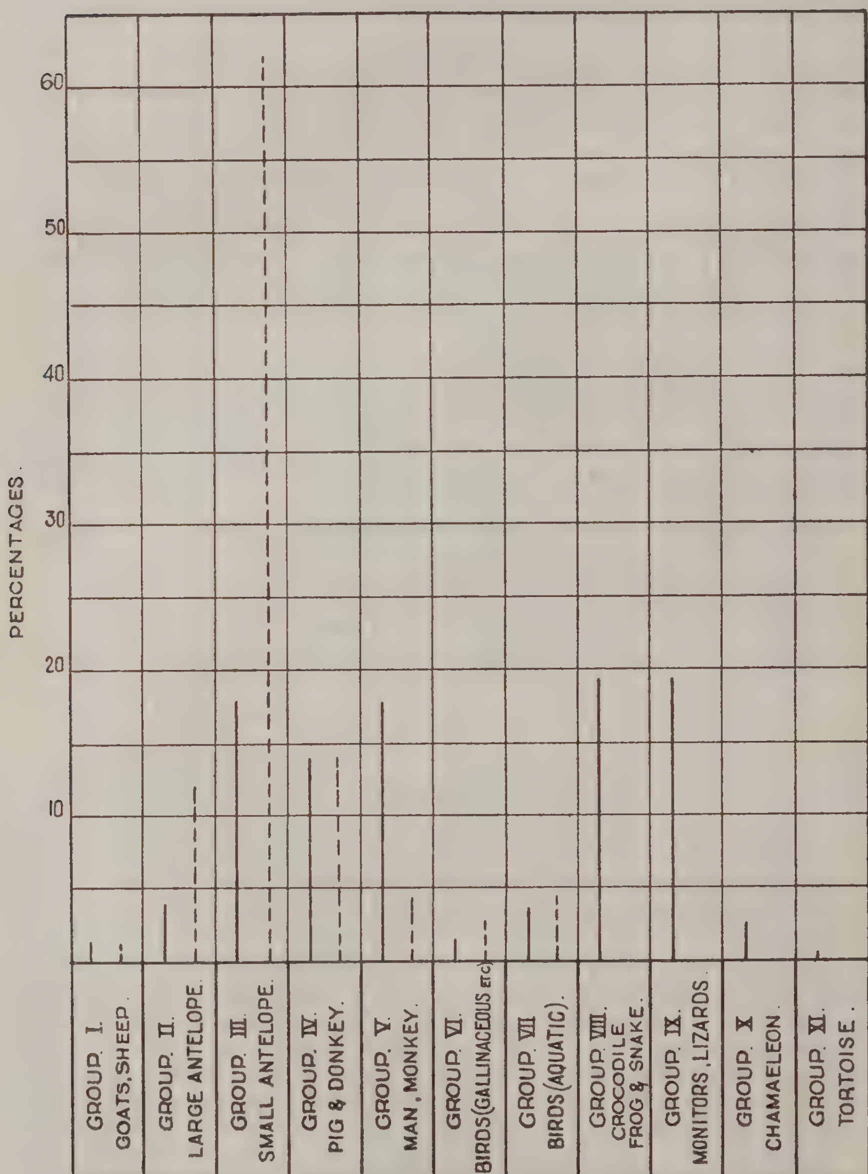
	Group.	Types.	Limit measurements of group in microns.	*G. tachinoides* 550 bloods measured.	*G. morsitans* 215 bloods measured.
Mammalian	I	Goat (3·0), sheep (3·5)	2·7–3·6	1·3%	1·4%
	II	Roan (4·1), waterbuck (4·5), korrigum (4·4), cattle (and probably buffalo) (4·5), fruit-bat (4·6).	3·7– 4·6	3·8%	12·1%
	III	Duiker (5·4), oribi (5·5), reedbuck (5·4), red-fronted gazelle (5·5), bushbuck (5·6), rat (5·4), ground squirrel (5·4), tree squirrel (5·4).	4·7– 5·6	17·8%	62·2%
	IV	Donkey (5·8), warthog (6·3) ..	5·7– 6·6	14·0%	13·9%
	V	Man (7·2), monkey (6·9), dog (6·9), jackal (7·3), hare (7·3).	6·7– 7·6	17·6%	4·2%
Avian	VI	Francolin (11·3), guinea-fowl (12·1), vulture (11·6), lesser hornbill (11·8).	11·3–12·4	1·4%	2·8%
	VII	Kingfisher (12·8), spur-wing goose (12·9), crowned crane (13·1), heron (13·4), wild duck (13·5), marabou stork (13·6).	12·5–13·6	3·5%	4·2%
Reptilian	VIII	Frog (14·1), colubrine snake (14·8), crocodile (14·4).	13·7–14·8	19·1%	0%
	IX	Lizard (15·0), *Varanus* (15·6), water *Varanus* (15·8).	14·9–16·0	19·1%	0%
	X	Chamaeleon (17·1)	16·1–17·2	2·4%	0%
	XI	Tortoise (19·9)	17·3–20·0	0·2%	0%

Figures in brackets after type animals denote the average measurement of red corpuscles from blood of these types.

The table also shows a difference in the non-mammalian blood taken by the flies. Out of a total of 26 encountered in *morsitans* 16 were measured and all of them fall into Groups VI and VII, which in the scale include only avian blood, and all 26 showed the distinctive characters of this blood, the nuclei of the erythrocytes being elongate oval, as against the more circular nuclei in reptilian and amphibian blood. On the other hand of 251 measured in *tachinoides* only 17 (10·8 per cent.) fall into the avian groups and 89 per cent. into the reptilian groups. Amphibia are included in these latter groups, but there is no evidence that tsetse feed on toads and frogs in nature. They only do so somewhat reluctantly in the laboratory when the mouths of the animals are tied, and they do not thrive on them. This 89 per cent. is almost certainly wholly reptilian. Of this it will be seen that about an equal amount comes from Group IX, which includes the two *Varanus*, and from Group VIII, which contains the crocodile* and snakes. Of these we consider that the crocodile is the most likely

* Although the measurement of erythrocytes distinguishes with fair accuracy between avian and reptilian bloods, it is considerably less reliable in differentiating groups of reptilian bloods in which microcytes and megalocytes are common, so that average measurements vary considerably, and the large size of the reptilian corpuscles gives a greater tendency to distortion. Average measurements of crocodile blood on different occasions have varied as much as from 14·4 to 16·1μ.

DIAGRAM I. CONTRASTING THE FOOD SUPPLY OF G. TACHINOIDES & G. MORSITANS. DURING THE WET SEASON.



CONTINUOUS LINE = G. TACHINOIDES.
INTERRUPTED LINE = G. MORSITANS.

host. *G. tachinoides* feeds readily upon young crocodiles in the laboratory, and although these animals are not apparently as numerous as *Varanus*, they are found in many of the localities whence our flies have been obtained, and their habitat makes them particularly accessible to the fly. Only one of the 550 bloods measured in *tachinoides* had the distinctive characteristics of that of the tortoise, and this blood has not been again seen in many hundreds of reptilian bloods encountered in the guts.

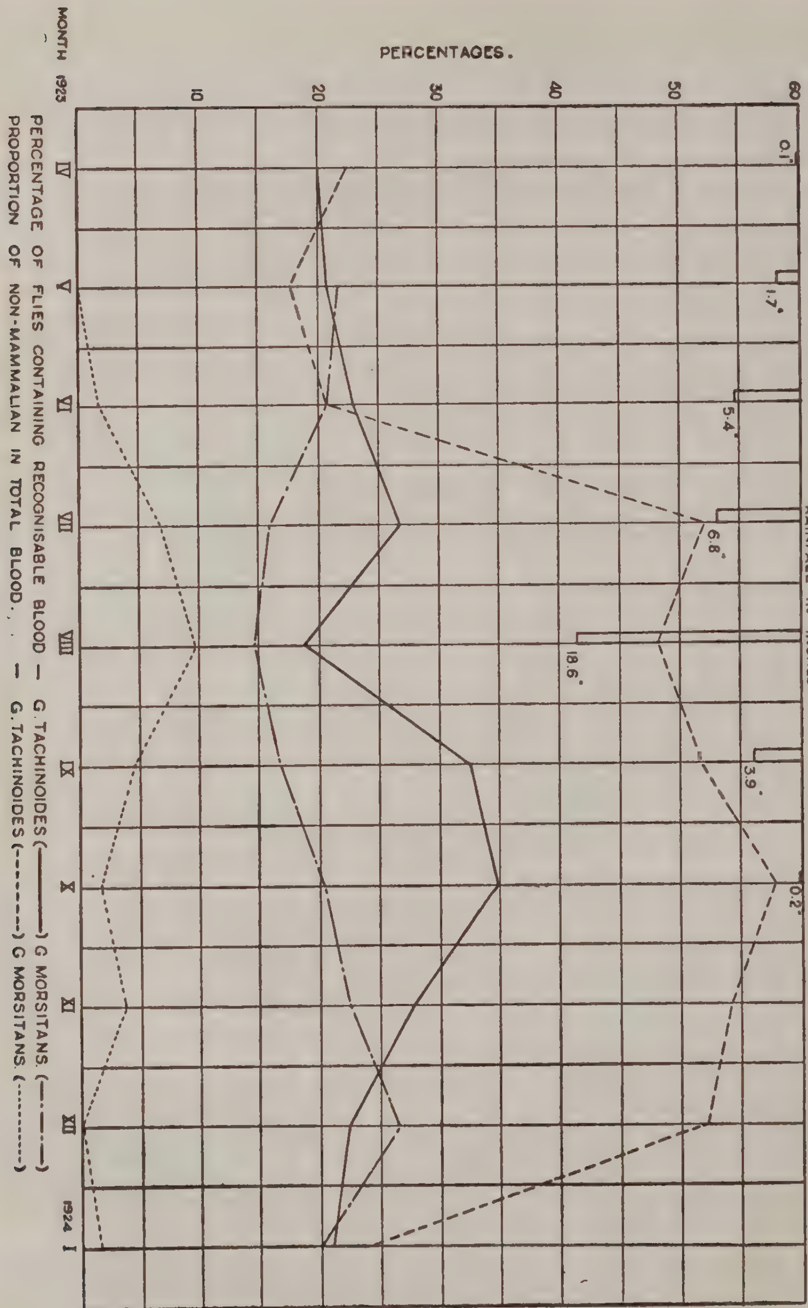
That the grouping of avian and reptilian bloods is at least fairly accurate is shown by the incidence of that characteristic reptilian parasite the haemogregarine. This was seen in all the reptilian bloods which form the scale and also in the toad. It was not seen in the guts of any of the flies which fall into the avian groups, but it occurred in the gut contents of the flies in the other groups as follows: Group VIII, 42 per cent.; Group IX, 45 per cent.; Group X, 54 per cent.

In both species of fly there is a considerable seasonal variation in the proportion of mammalian and non-mammalian blood, and an analysis prepared in the dry season would give a very different result from that detailed. This difference is shown in Diagram 2, which gives the monthly percentage of flies in which recognisable blood was encountered and the proportion of this which was non-mammalian. The monthly rainfall is shown at the top of the diagram. It will be seen that at the end of the dry season *tachinoides* is taking little non-mammalian blood and *morsitans* hardly any. This is the time when mammals are most conspicuous in the bush and the land *Varanus* is hibernating. Through the rains, as the grass grows, *morsitans* obtains less food, and it is clear that hunger forces it to attack birds, as it is only when its diet is at the minimum that avian blood is taken in any considerable proportion. *G. tachinoides*, on the other hand, is well fed during this period owing to the availability of reptiles. In August, however, the month of greatest flood, reptiles become less accessible owing to their dispersal, and consequently *tachinoides* has a month of hunger, mammals being as inaccessible to it as to *morsitans*. As the waters fall and the reptiles concentrate, *tachinoides* again becomes well fed. This plenitude of food results in rapid breeding as soon as the rains abate, and the curve representing the proportion of recently fed flies falls in November and December, not because their food is scarce, but because an increasing proportion of young flies that have not fed at all are encountered in the dissections. In October grass burning starts, and the antelope, the main food of *morsitans*, become more conspicuous, and in consequence this fly again becomes well fed and the proportion of avian blood in its diet is reduced by December to the dry season level of almost nil. This increase of food results in the main breeding season starting later than that of *tachinoides*, because the increase of food comes later and the emergence of young flies is insufficient to cause a fall in the food curve till January. The *morsitans* breeding season thus starts some six weeks to two months later than that of *tachinoides*. This recalls an old observation of one of us in Northern Rhodesia that *morsitans* begins to breed freely only when the cold months of the dry season are over, that is in July and August. This roughly corresponds to the time of grass burning, which follows about three months after the cessation of the rains in early April in that country.

In our last report we dealt with *tachinoides* at Mashiwashi in South Sokoto Province (2). At this spot the fly was a mammal feeder; no non-mammalian blood was ever encountered in the guts examined and no evidence of the presence of amphibious reptiles was obtained. Here we showed that there was hunger in the flies throughout the wet season, and at the end of this time only 14 per cent. were found to be "well nourished." This is in great contrast to *tachinoides* in the Sherifuri district, where there is such an accessible alternative diet.

We have already shown that the breeding of these two species of tsetse is almost confined to the dry season. Certain confirmatory evidence may be given. It is unfortunate that figures relating to soft young flies met with in dissection were not kept over a longer period. It was the striking increase of these after the rains of

DIAGRAM II. ILLUSTRATING THE SEASONAL VARIATION IN NUTRITION OF G TACHINOIDES AND G MORSITANS AT SHERIFURI



1923 and their bearing on the incidence of infection that caused the record to be kept. Through the rains occasional individuals of *tachinoides* were encountered in dissection in which the ptilinum was forced out during manipulation, and this is evidence of a young fly. Quite suddenly in November these began to increase, and in the second half of that month they totalled 70 (10·1 per cent.) in 690 flies. In the same period there were 3 (1·0 per cent.) in 290 *morsitans*. In December there were 237 (22·7 per cent.) young flies in 1,046 *tachinoides* and 26 (5·0 per cent.) in 516 *morsitans*. In January these numbers increased to 234 (28·5 per cent.) in 820 *tachinoides* and 70 (10·0 per cent.) in 700 *morsitans*. Allowing for the 30–40 days pupation period at this cool season, free breeding of *tachinoides* therefore started early in October and free breeding of *morsitans* late in November. The figures obviously bear a close relation to the preceding rises in the food curves. If old and young flies were caught in the proportions in which they were actually present *tachinoides* would be nearly doubling its numbers every fortnight in the middle of the dry season. It is more probable that the young flies, being hungrier and perhaps less agile than the older flies, are caught more readily by the net.

There is also evidence afforded by a study of the proportion of pupae and empty pupa-cases collected in nature that the breeding season is really restricted to the dry months. In the earlier part of the dry season empty cases are rare and pupae relatively numerous, while at the end of the dry season the reverse is the case. The figures for *tachinoides* are given in Table III as a discontinuous record over a period of two years. It will be seen that at the beginning of each dry season 90 per cent.

TABLE III.

Evidence as to the Breeding Season of Glossina tachinoides.

Month.	1921–22.	1922–23.	1923–24.
October ..			Sherifuri (21) 90% pupae
November		Dingaiya Valley (123) 93% pupae	Sherifuri (968) 90% pupae; Middle Niger (2,217)* 95% pupae
December		Sheriful (358) 68% pupae	Sheriful (1,603) 77% pupae; Middle Niger (1,314)† 81% pupae
January ..			Sheriful (2,018) 61% pupae
February	Middle Benue (1,046) 36% pupae	Sheriful (148) 57% pupae	
March ..		Sheriful (741) 63% pupae	
April ..		Sheriful (121) 23% pupae	
May ..	Mashiwashi (6,341) 2% pupae	Sheriful (147) 23% pupae	

The figures in brackets show the total pupae and empty pupa-cases collected.
* 9% of these were *G. palpalis*.
† 12% of these were *G. palpalis*.

or more of the total collection are pupae, and the small percentage of cases, of course, includes any which have remained undestroyed from the previous year. On the Niger the season is later at the point where the pupae were collected, and this accounts for the smaller proportion of empty cases found there in November and December as compared with Sheriful in the same months. The high proportion of pupae (23 per cent.) at the latter spot in April and May compared with the low one (2 per cent.) at Mashiwashi in May is accounted for by the fact that the latter spot was visited

then for the first time, while the Sherifuri figures include collections from spots previously depleted of pupae. The actual number of pupae collected in these two months only totalled 62, or 6 to a collection, as against 39 to a collection in March. Breeding was therefore actually much reduced at the onset of the rains, and in the height of the wet season we have been unable to find any breeding-grounds or to unearth more than an occasional pupa-case.

VI. Local Variations in Food and Infection.

G. tachinoides has been examined from six and *G. morsitans* from three different parts of the area over a period of twelve months, and in some cases a little more. Owing to *tachinoides* leaving the pools soon after these dry and returning to them in sufficient number only after several weeks of rain, the continuity of the monthly records is in some cases broken. One of the localities, the south bank of the main river, was inaccessible to the fly-boys for three months owing to floods. The flies were caught in nets with or without the aid of umbrellas and no bait animals were used. As the boys were generally instructed to bring in a small limited number of flies, they never lingered over the collection but caught the flies rapidly as they came around. Consequently the records of fresh blood in the guts will contain a very small proportion of collectors' blood. The examination consisted of the dissection of the proboscis and the anterior parts of the salivary glands by the method we have described in detail (2). All trypanosome infections discovered were noted and all which were mature were mounted and identified. From April onwards guts were also examined and the quantity and type of recognisable blood was noted, while all flagellate infections of the gut were mounted and identified. The rules followed in identification were given in our last report and need not be recapitulated. It suffices to state that in Nigeria four species of tsetse-borne pathogenic trypanosomes are known, namely :— *T. vivax*, *T. congolense*, *T. brucei* and *T. gambiense*. The first two are readily distinguishable from each other and from the last two, but *T. brucei* and *T. gambiense*, which have their final stage in the fly in the salivary glands, cannot be distinguished from each other by their morphology in the fly and will therefore be referred to as the *brucei-gambiense* group. There remains only a flagellate infection confined to the gut in *tachinoides*, *T. grayi*, which is derived from the blood of reptiles and which is readily distinguishable from the pathogenic trypanosomes.

We have still misgivings as to whether all the *brucei-gambiense* group infections are discovered by this method of dissection, since so few (3 in 7,000 *morsitans* and 4 in 12,000 *tachinoides*) have been found. Also in two out of nine laboratory-bred flies which were experimentally infected with these trypanosomes, the forms in the salivary glands could not be detected by the examination of the fresh preparations of the entire glands and only appeared in small numbers when the gland was teased up and stained. However, heavy infections are very obvious, and exceedingly few gut infections of the group have been seen apart from those of the seven mature infections. Curiously, of these seven flies no less than six had heavy mature infections of *T. congolense* as well as of the *brucei-gambiense* group, the infective and developmental forms of both being found in large numbers. The remaining one was of interest on account of its lightness. Three flagellates were detected in the exudate at the cut ends of the glands, and careful examination by three of us could discover none through the unbroken walls of the glands. The infection was confirmed by the staining, as two pairs of crithidia and one infective form with the characters of the group were found in the film. This is a case in point of a gland infection which careful examination might have failed to detect.

The results of the dissections classified under their localities and months are given in Table IV for *tachinoides* and in Table V for *morsitans*. For the sake of simplicity all figures are given in percentages. In all, 19,669 proboscides and 13,070 guts have been examined, and the percentages are therefore based on an average number of 187.

TABLE IV.

Analysis of Infections and Food Supply of G. tachinoides *from Localities about Sherifuri ; all in Percentages.*

Locality.	Month.	1922. XII	1923. I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	1924. I
South Bank of Main River	Proboscis infections ..	—	12·2	14·4	19·0	12·5	8·7	3·3	—	—	—	10·0	9·2	6·9	7·0
	Mammalian blood ..	—	—	—	—	10	23	18	—	—	—	19	18	19	12
	Non-mammalian blood	—	—	—	—	0	0	4	—	—	—	14	10	7	0
	T. grayi infections ..	—	—	—	—	0	0	0	—	—	—	0	0	0	0
Main Road Pond	Proboscis infections	1·0	2·4	0	1·6	5·7	—	8·7	16·0	21·0	9·4	15·6	10·0	3·1	4·6
	Mammalian blood ..	—	—	—	—	15	—	17	11	5	15	7	7	9	10
	Non-mammalian blood	—	—	—	—	9	—	11	16	11	11	28	13	16	12
	T. grayi infections ..	—	—	—	—	0	—	0·7	1·5	0·3	1·4	0·4	0	0	—
Village Pond	Proboscis infections ..	0·6	0	—	2·0	—	—	—	—	22·0	12·5	7·2	6·7	4·0	—
	Mammalian blood ..	—	—	—	—	—	—	—	—	12	19	14	18	19	—
	Non-mammalian blood	—	—	—	—	—	—	—	—	7	16	22	12	3	—
	T. grayi infections ..	—	—	—	—	—	—	—	—	4·0	1·0	0·4	0	0	—
Eastern Pond	Proboscis infections ..	12·0	10·5	6·2	9·0	13·7	13·6	13·6	10·0	7·2	5·5	11·2	7·0	4·4	9·2
	Mammalian blood ..	—	—	—	—	26	19	18	11	14	15	10	6	6	13
	Non-mammalian blood	—	—	—	—	3	14	6	4	4	3	12	13	11	5
	T. grayi infections ..	—	—	—	—	0	0	1·1	1·1	0	0·5	0·4	0·9	5·8	4·1
Broad Pond	Proboscis infections ..	—	3·0	10·0	3·3	11·2	—	—	—	26·0	14·4	10·4	6·9	13·3	11·2
	Mammalian blood ..	—	—	—	—	—	—	—	—	11	12	13	27	11	25
	Non-mammalian blood	—	—	—	—	—	—	—	—	10	14	20	13	4	0
	T. grayi infections ..	—	—	—	—	—	—	—	—	1·5	4·0	0	0	0	0
Kiyawa River	Proboscis infections ..	—	—	0	0	0	0	0	0·5	0·7	1·2	2·0	1·5	0·7	—
	Mammalian blood ..	—	—	—	—	10	15	16	14	10	18	25	7	5	—
	Non-mammalian blood	—	—	—	—	4	3	11	26	11	23	20	25	33	—
	T. grayi infections ..	—	—	—	—	5·7	0·4	1·3	2·5	1·4	0·8	1·2	2·7	11·4	—

TABLE V.

Analysis of Infections and Food Supply of G. morsitans *from Localities about Sheriful ; all in Percentages.*

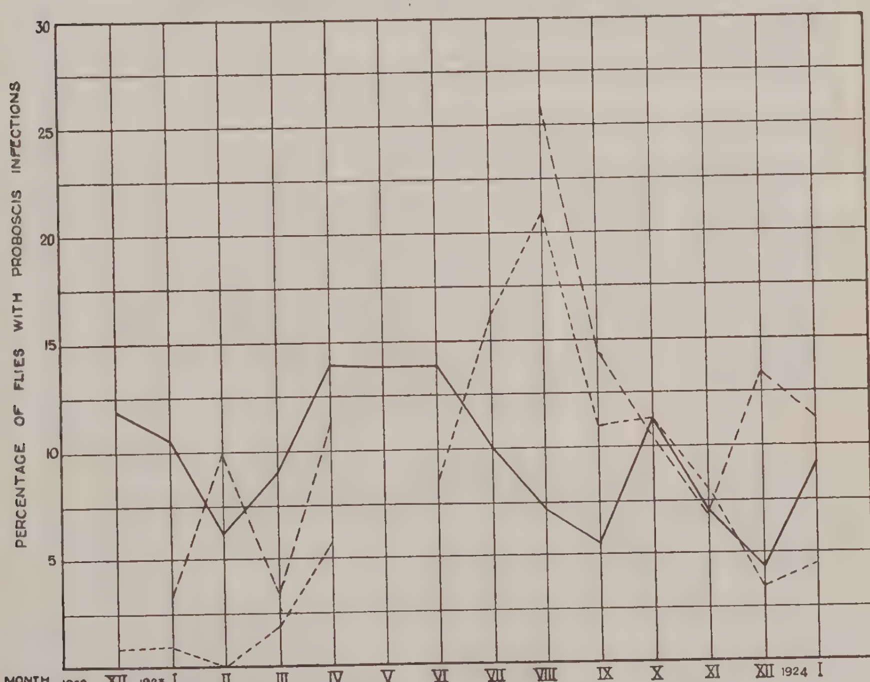
Locality.	Month	1922. XII	1923. I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	1924. I
South Bank of Main River	Proboscis infections ..	—	—	46·0	18·7	13·7	32·7	36·2	—	—	—	26·5	35·4	32·7	54·0
	Mammalian blood ..	—	—	—	—	—	23	30	—	—	—	17	12	30	25
	Non-mammalian blood	—	—	—	—	—	0	0	—	—	—	0	0	0	0
Village Pond	Proboscis infections ..	18·7	14·5	15·6	10·2	12·5	31·0	57·5	42·8	35·7	25·3	14·5	15·8	22·5	24·2
	Mammalian blood ..	—	—	—	—	—	42	15	14	15	17	22	23	26	19
	Non-mammalian blood	—	—	—	—	—	0	1	2	3	2	0·5	0	0	0
Eastern Pond	Proboscis infections ..	—	53·5	43·1	32·0	25·0	27·0	39·0	35·2	28·7	19·3	13·0	31·0	36·3	34·6
	Mammalian blood ..	—	—	—	—	18	20	26	15	14	14	14	26	25	27
	Non-mammalian blood	—	—	—	—	—	0	0	0	0	0	0·5	2	0	0

Of the 175 monthly groups of proboscides and guts involved only one group numbers less than 50 (40) flies and 33 were between 50 and 100. Generally the flies were brought from the various localities in rotation, so that those of each month are for the most part compiled from figures collected from three days' dissection separated by intervals of about ten days. A few of the figures are erratic, but on the whole they conform remarkably well, increases and decreases being usually steady and continuous over about three months. They will be considered briefly under the locality headings. *T. grayi* will be dealt with separately.

1. *South Bank of the Main River.*

Both species of flies were examined while this part was accessible. The flies were caught within half a mile of the main road to the west in the edge of the heavy forest bordering the river or in the baobab bush which adjoins it. At the end of the dry season *morsitans* became scarce to the west of the road, and these flies were caught

DIAGRAM III. ILLUSTRATING THE SEASONAL VARIATION OF INCIDENCE OF PROBOSCIS INFECTIONS OF G. TACHINOIDES FROM THREE LOCALITIES ABOUT SHERIFURI



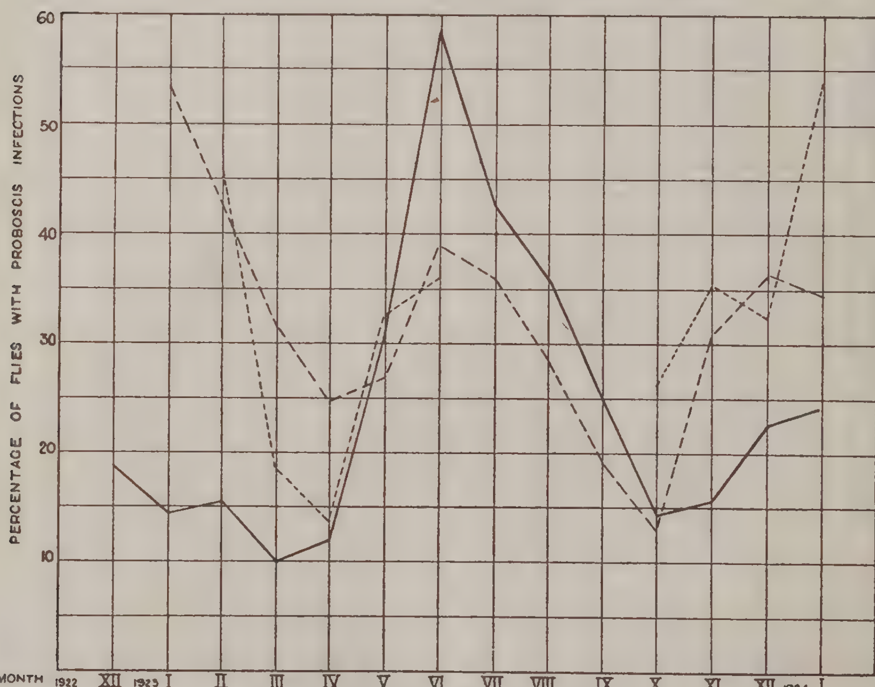
LOCALITIES { CONTINUOUS LINE = EASTERN POND. INTERRUPTED LINE = BROAD POND DOTTED LINE = MAIN ROAD AND VILLAGE PONDS.

to the east of it where there is better grazing ground. At the beginning of the dry season small game is plentiful in the heavy thorn forest but soon becomes scarce, for there is no good grazing abutting on it as there is in most of the other localities where we examined the flies. The proboscis infection of *tachinoides* was high (12·2 per cent.) in January and rose in the next two months to 19 per cent., which was the climax,

as it then fell rapidly till in June it was only 3·3 per cent. There was a gap of three months owing to floods, and in October the infection was 10 per cent., falling to 6·9 per cent. by December. This latter fall in three months is parallelled in all the localities except no. 5, the Broad Pond (see below), and is due to rapid breeding and the dilution of the old flies with young ones which have had less chance of becoming infected. The figures for the early part of the year are puzzling, the infection rising as it falls in other localities and falling again when the rise in other places occurs. It is not clear what factor caused this. The seasonal variations are illustrated in Diagram 3.

Reptiles are less available here than in the other localities in the early dry season, as the few pools are small and dry soon after the rains cease, and though the main river is near, it is at an important ford and much disturbed. Consequently here the reptilian blood in *tachinoides* is never in excess of the mammalian so far as the records go. Hence as the fly is mainly a mammal feeder and antelope are generally available, the infections are fairly constantly high and comparable with those of no. 4, the Eastern Pond.

DIAGRAM IV ILLUSTRATING THE SEASONAL VARIATION OF INCIDENCE OF PROBOSCIS INFECTIONS OF G MORSITANS FROM THREE LOCALITIES ABOUT SHERIFURI.



LOCALITIES { DOTTED LINE = SOUTH OF MAIN RIVER. CONTINUOUS LINE = VILLAGE POND. INTERRUPTED LINE = EASTERN POND.

The figures for *morsitans* call for little comment and are of less interest than those of the other localities owing to the break. They are most comparable with those of the Eastern Pond, the proboscis infection in February being high (46 per cent.) and falling in the next two months owing to rapid breeding, the minimum point (13·7 per

cent.) being in April, as in the other localities. There follows a rapid rise at the beginning of the rains to 36·2 per cent. in June. By October the figure has fallen to 26·5 per cent. and rises at the burning of the grass to 35·4 per cent. in December and 54 per cent. in January. These variations are illustrated in Diagram 4.

2. *The Main Road Pond.*

This is a shallow pool about half a mile in length with much mimosa in its bed. At one point it comes to within a hundred yards of the main road. At the south end is an extensive thicket of thorns, which elsewhere form a narrow border. Between it and the road is open baobab bush, but to the west is an area of long-grassed heavy forest. It dries about mid-April and for the two previous months is used as the water supply of the village Dumugu and is much frequented by women. It is secluded only in the height of the rains, when it floods over the main road and there is little traffic. Small game and pig frequent it on the west through most of the year, and during the rains larger antelope visit it. *G. tachinoides* is abundant here in the dry season till two or three weeks after the pool has dried, when it disappears, to re-appear a month or so after the onset of the rains. It is often seen on the main road in the evenings and feeds on passers-by. There are numerous monitors about this pool, and the blood records show that the fly feeds more on reptiles than on mammals from July to January with the exception of September, the flood month. An analysis of the mammalian blood from June to September showed that 53 per cent. of it was probably derived from antelope and about an equal quantity of the remainder from the pig-donkey and man-monkey groups.

The proboscis infection of *tachinoides* was low from December to March (0 per cent.–2·4 per cent.) and rose in April to 5·7 per cent., when the pool is about dry and no longer attractive to reptiles. A sounder of warthog had at this time a burrow in the bank. When the fly reappeared, after an interval of a month, the infection was 8·7 per cent. and rose in the next two months to 21 per cent. In September there is a rapid fall to 9·4 per cent., which looks like an erratic figure, though the proportion of non-mammalian blood in the preceding month was very high and the rise of infection to 15·6 per cent. in October follows a rise in mammalian blood. Thenceforward there is a rapid fall to mid dry season level, coincident with the dilution of old flies with young and the excess of reptilian over mammalian blood in the diet of the flies. These figures, in combination with those of the next locality where the tendencies were the same, are illustrated in Diagram 3.

3. *The Village Pond.*

This pool is the one nearest to the village Dumugu and is used as a water supply for three or four months in the dry season till the water fails at the end of January. Donkeys also are sometimes watered there. Except for this period the pool is more secluded than the one just discussed, being separated from the main road by a few hundred yards of heavy forest. On its other bank the open baobab bush comes right up to the narrow thorn belt. While the pool is used as the village water-hole duiker and gazelle still visit it, and when the water dries these, together with bushbuck and warthog, are much there. During the rains, when the bush to the east is flooded. there is much small game in the better drained forest between it and the main road, The pool is also occasionally visited by roan and buffalo. Monitor lizards were often seen there.

G. tachinoides is confined to the banks of the pool in the early dry season and disappears about a month after the water has dried. It did not return in the early rains but reappeared in August, when it was plentiful in the heavy forest abutting on the road. In this and the next month an analysis of its food showed that 8 per cent. of its mammalian blood was drawn from the goat group ; 65 per cent. from the antelope group ; 24 per cent. from the pig-donkey group, and 3 per cent. from

the man-monkey group. This and the Kiyawa River are the only localities where blood of the goat-sheep group was found in the flies. *G. morsitans* was not numerous in the dry season, when it was largely confined to the margin of the forest bordering the pool. It spread very widely over the whole area during the rains, being very numerous between the pool and the road and upon the road itself. It remained about the pool after *tachinoides* had left. The analysis of the mammalian food of *morsitans* from May to September showed that 84 per cent. was derived from the antelope groups, 10 per cent. from the pig-donkey groups, and the remainder equally from the other two groups.

G. morsitans was examined here through the whole period and *tachinoides* when it was available in sufficient numbers. Through the later part of the dry season the proboscis infection of *tachinoides* was low (0–2 per cent). When the fly re-appeared in August the infection reached the very high figure of 22 per cent. It is of interest to note that this figure is almost the same as that of the Main Road Pond in this month, and reference to the map will show that in flood the two ponds are almost continuous. The invasion probably followed this route. From this point the infection fell very steadily till it reached the low figure of 2 per cent. at the end of December, the infection at the beginning of the month being 5 per cent. From September to November the fly obtained a large proportion of its food from non-mammalian sources and there was a rise in mammalian blood from December. The infection at this point in conjunction with that of the last locality is shown in Diagram 3. In August one *tachinoides* was found to have a mature infection of the *brucei-gambiense* group, and in the same month a case of sleeping sickness was discovered in the village of Dumugu.

The record of the infection in *morsitans* is complete over a period of fourteen months. In December 1922, 18·7 per cent. of the flies had proboscis infections, and the figure fell to 10·2 per cent. in March, which was the minimum reached. After this there was a rise to 12·5 per cent. in April and the maximum of 57·5 was reached in June, the culminating point being at the end of the month, when no less than 63 per cent. of 100 flies showed proboscis infection. About half these infections were immature, while 27 per cent. had mature infections of *T. vivax* and 5 per cent. mature *T. congolense*. After this there was a slow steady fall to 14·5 per cent. in October, in which month the grass to the east of the pool was burnt. There followed a rise to 24·2 per cent. in January. One mature infection of the *brucei-gambiense* group was discovered at this spot in *morsitans*.

The incidence of the proboscis infections of *morsitans* is shown in Diagram 4, contrasted with two other localities which are more secluded in the dry season. The conclusion which would naturally be drawn is that the flies here are obtaining much of their food from sources other than the antelope, especially the water-carriers, but this is not borne out by the facts. At this time the fly is not present in great numbers and is not aggressive, while sometimes those required for dissection are with difficulty obtained. There is little in the record of the female percentages to show that the fly is more attracted to people here than elsewhere. From January to March the females numbered 13 to 18 per cent. of the catches as against 6–7 per cent. at the Eastern Pond in the same months. This shows a slight deficiency of food. At other times the proportion of the sexes at the two spots was about the same. The proportion of soft young flies was also about the same. In January 1924, when the infection was 24·2 per cent. as against the 34·6 per cent. of the Eastern Pond, a series of bloods was measured in the fly here. Of 33 so tested the smallest red cell measurement was $4{\cdot}6\mu$ and the largest $5{\cdot}6\mu$, the average of all being $5{\cdot}1\mu$. These bloods thus fell into Group III, the duiker-oribi group. One-third of the flies examined for this purpose were caught at the actual spot where the water-carriers come down. *G. morsitans*, therefore, is making no particular attack on man or donkeys here, and at present no reason for the relatively low dry season infection can be given. The interest of the figures is that they show how little circulation of *morsitans* there is in the bush at

the dry season. The point is only two miles distant from the spot where the more heavily infected Eastern Pond flies were caught, two miles from the main river and one mile from the old river bed and with another focus intervening. If circulation of fly was occurring between these points a more even rate of infection would be expected. This recalls Shircore's views on the dry season "primary centres" of *G. morsitans* in Nyasaland (3).

4. *The Eastern Pond.*

This piece of water lies in the old river bed and is a very deep permanent pool. It is normally a secluded place, but from April to June women of Dumugu draw water there and in September and October fishermen visit it to set traps in the falling water. Donkeys are only very occasionally brought here by charcoal-burners. The pond differs from the others in that it is separated from the shorter-grassed baobab bush by an extensive area of long-grassed forest and to the east is bordered by the long-grassed river plain. This seems to be of importance, for when the long grass is up the antelope are more effectively concealed from the flies. This would possibly account for the infections in both species being lower here from July to October than at most of the other points. The larger antelope are here occasionally in the dry season, while duiker, oribi, bushbuck, reedbuck and warthog are all fairly plentiful. Monitor lizards are present and crocodiles also. Both species of fly are abundant all the year through.

An analysis of the mammalian blood in *tachinoides* from May to September showed that none was referable to the goat group ; 55 per cent. to the antelope groups (in contrast to 65 per cent. at the Village Pond) ; 20 per cent. to the pig-donkey group ; and 24 per cent. to the man-monkey group. In August and September, however, only 40 per cent. came from the antelope groups and a correspondingly larger proportion from the other groups, especially from warthog (39 per cent. in September), donkeys being not present then. In *morsitans* over the same five months, 73 per cent. was referable to the antelope groups (in contrast to 84 per cent. at the Village Pond), 17 per cent. to the pig group and 10 per cent. to the man-monkey group.

G. tachinoides has been examined here for fourteen months and *morsitans* for thirteen. In *tachinoides* the proboscis infection starts with a high figure (12 per cent.) in December, comparable only with that of the south bank of the main river in the next month and with that of the Broad Pond (see below) in December of the next year. It is a high rate of infection for *tachinoides* at this season, when so many young flies are included in the examination. The infection fell for the next two months to 6·2 per cent. and rose again to a maximum of 13·7 per cent. in April. In July it began to fall and continued to do so till October, when there was a sudden rise to 11·2 per cent. This was followed by a fall to 4·4 per cent. in December, as against the 12 per cent. infection of the previous December. The food records show that the fly during the rains, with the exception of May, was largely a mammal feeder, and in October the non-mammalian blood was for the first time in excess of the mammalian. In the next two months the supply of the latter blood evidently was reduced, there being no corresponding rise in the reptilian food supply. At this time two factors may have had some effect on the antelope of the locality. Firstly, a lion took up its residence there and was often heard roaring near the pool, on several days as late as eight o'clock in the morning. Secondly, an attempt at trapping tsetse was made there. As this failed it need not be described, except to say that a fence, at first of grass mats and later of wire netting, was constructed across the denser part of the forest bordering the pool and remained there for three weeks. It is very probable that these two factors, absent in the previous year, account for the lowering of the mammalian blood supply and the low infection. In late December the lion was not in evidence and the fence had been removed. The proportion of mammalian blood in the diet rose from 35 per cent. in December to 71 per cent. in January, and the

infections rose from 4·4 per cent. to 10 per cent. in spite of the dilution with young flies, which was equal here to that at other points. The proboscis infection is illustrated in Diagram 3.

G. morsitans in January, 1923, showed the heavy proboscis infection rate of 53·5 per cent. (26 per cent. mature *T. vivax* and 9 per cent. mature *T. congolense*). The infection fell to 25 per cent. in April and with the early rains began again to rise, but much less rapidly than at the Village Pond, as was the case also with the infection of *tachinoides*. The highest point reached was the 39 per cent. in June, and thenceforward during the long-grass season there was a steady fall to a minimum of 13 per cent. in October, with a fresh rise to 36·3 per cent. in December and a slight fall in January. The factors mentioned above in the last paragraph no doubt account for the lower figure at this time than in the previous year.

5. *The Broad Pond.*

This is a broad shallow pool in the bed of the Malele River, which dries up early in February. There is the usual thorn thicket on its bank, and this is bounded to the east by the baobab bush and to the west by the sand ridge on which the camp is built. A year before the work began there was a small village, Tulu, near this pool, but it had been deserted on account of sleeping sickness. At the time of our arrival there was still some farm land at the south end of the pool, but it had not been extensive on the bank and the whole has now reverted to bush. Much of the ridge here is rather heavily forested. A path crosses the pool but is little used and the place has become very secluded. During the early dry season *tachinoides* was present in numbers, but there were very few *morsitans*. After the pond dried the flies became scarcer and at the end of April were no longer obtainable. About mid July, when the water stood in pools, *tachinoides* reappeared in gradually increasing numbers, and a month later *morsitans* also became numerous and remained so till October. The smaller antelope and warthog are prevalent here all the year and reedbuck in the rains; roan occasionally pass. Monitor lizards were often seen, but by December the water has receded from the overhanging trees and there is no mimosa in the pool to shelter these animals. This no doubt accounts for the disappearance of non-mammalian blood in the diet of *tachinoides* in January.

G. tachinoides has been examined when available over a period of thirteen months. The infection figures of the earlier months are erratic, low and moderately high rates alternating. When the fly reappeared it had the highest infection rate (26 per cent.) recorded for *tachinoides* in this district. This fell to 6·9 per cent. in November, the fly having fed largely on reptiles in the two preceding months. From November onwards it became a mammal feeder, with an infection rising to 13·3 per cent. and 11·2 per cent. in December and January. This rise is actually more rapid than is shown, as in November the young flies numbered 6 per cent., in December 15 per cent., and in January 26 per cent. of those dissected. This incidence of infection is illustrated in Diagram 3.

Among the 1,690 *tachinoides* examined from this locality there were three flies with mature infections of the *brucei-gambiense* group. The salivary glands of one of these were inoculated into a monkey and proved the infection in that case to be *T. brucei*.

G. morsitans was not examined from this spot, but in January, 1924, 220 were dissected from a point a mile further east. In these there were 76 (34·5 per cent.) infections of the proboscis, 10 per cent. of the examined flies being young. It is of interest that in these flies mature *T. vivax* infections totalled 12·3 per cent. and *T. congolense* 12·7 per cent. This is a unique instance in *morsitans* where *T. congolense* ever approached an equal prevalence with *T. vivax*. In these flies also two mature infections of the *brucei-gambiense* group were found.

6. *The Kiyawa River.*

This stream has been sufficiently described in the earlier part of this paper. Most of the 2,070 *tachinoides* which have been examined from this locality were caught within half a mile of the main road crossing. They were readily obtained except in the earlier part of the dry season, when they were exceedingly scanty. On one suitable day in November three fly-boys obtained only 53 flies in three hours' work. In December increase through breeding began and thenceforward the flies were caught with ease. No *morsitans* were ever seen at this point, but they occur on the river in small numbers a few miles further east.

Man is a potential source of food throughout the year. The stream forms the water supply of the village Babuwuri; there is also much fish trapping and many travellers pass the ford. Goats and donkeys constantly graze along the bank in the dry season and a considerable number of domestic stock, except cattle, also pass. Game is scanty, but an occasional gazelle and duiker has been seen near the river. Monitor lizards are very numerous and crocodiles occur at times. The very long grass of the banks is burnt in February. As stated above, the open baobab bush does not approach the river at this point.

An analysis of the mammalian food of the fly from May to September showed that 7 per cent. was derived from the goat group; 8 per cent. from the antelope group; 42 per cent. from the pig-donkey group (warthog being absent; this is probably mainly donkey blood) and 43 per cent. from the man-monkey group (this probably includes some from dogs.) Compared with the other localities the paucity of antelope blood is very striking and is compensated for by the rise in the last two groups. However, for much of the year the fly draws the bulk of its food from reptiles. The water ceased to flow in mid April and commenced running again at the end of June, reaching its greatest height at the beginning of October, and began to fall at the end of this month. Reptilian blood began to predominate in the diet in July and was in excess of the mammalian blood in each month till January with the exception of the flood month. In November and December 83 per cent. of the food of the fly was non-mammalian blood.

The very light infection is striking. From February to June, 650 flies were examined without discovering a single proboscis infection, while in the rest of the period the highest rate of infection was only 2 per cent. Further, in the total 15 proboscis infections discovered here 13 were mature. This is slight evidence that some at least of the infected flies were invaders at this spot. since at a point where infections are being acquired a higher proportion of immature infections is expected.

The stream is the centre of the sleeping sickness area in this locality, but no mature infections of the *brucei-gambiense* group were discovered. Among 1,894 guts examined a single immature infection of the group was detected. At this time and place the sleeping sickness infection is therefore very scanty in the fly.

VII. Trypanosoma grayi in Glossina tachinoides.

This flagellate is confined to the gut and has been recorded from *G. palpalis* and *G. tachinoides*. It has not occurred in the 4,800 *G. morsitans* whose guts we have examined. Kleine obtained it in *G. palpalis* by feeding these flies on crocodiles, and we have obtained it in *G. tachinoides* in a similar way. We showed how close a relation it bears to the occurrence of reptilian blood in *tachinoides* and on the grounds of incidence suggested that it was probably derived from *Varanus*. Its distribution at various times and places in this locality is shown in Table IV. This shows that it has been found at each focus with the exception of the South Bank of the Main River. At the three ponds which dry completely it was found only in the wet season from June to October, and its appearance at these coincided with the new invasion of the fly, so that the infections were not necessarily acquired at the spots where the

flies were caught. It was most prevalent at the Eastern Pond and the Kiyawa River. At the former it was found in 5·8 per cent. of the flies in December and this prevalence clearly followed a rise in reptilian blood in the diet. At the Kiyawa River it occurred in each month of which there is a record, and in January was present in 16·3 per cent. of the flies after a month in which 87 per cent. of the blood seen in the guts was reptilian. Crocodiles as well as both species of *Varanus* were present at these two places, but the former would not be expected in the other pools except in flood time. The incidence here suggests that crocodiles are at any rate the main hosts of the flagellate outside the fly.

The crocodile harbours *T. kochi* and both species of *Varanus* harbour a closely allied trypanosome, *T. varani* Wenyon. In our experience this latter trypanosome is very scanty in the blood and has only been discovered after double centrifuging. The method was based on that described by Blanchard and Lefrou (4), who recommend triple centrifuging for the isolation of spirochaetes and trypanosomes, but the third spinning in this case was found to be unnecessary and sometimes a drawback. Spreading the concentrate and staining with Giemsa stain by the ordinary method gave very unsatisfactory results. Various attempts were made to overcome this difficulty and the following method was found to be most successful. A small quantity of unspun blood was mixed with a minimum of sodium citrate solution and was kept in a moist chamber till the spinning was complete. The concentrate was then mixed with 1/20th cc. of this and could be spread like fresh blood and gave very good staining results by ordinary Giemsa methods. The *Varanus* was killed by a light blow on the head and about 15 cc. of blood could then be obtained from the large vessels near the heart, 9 cc. was mixed with 1 cc. of 20 per cent. sodium citrate solution and spun till the cells compacted. The supernatant serum was pipetted off and spun for 10 to 15 minutes at 2,000 to 3,000 revolutions a minute. The clear fluid was again decanted and rejected, and the concentrate left was mixed with the unspun blood and spread. A large majority (67 per cent. of 84 examined) of the land *Varanus* and the single water *Varanus* examined were found to harbour the trypanosome.

In order to discover whether this trypanosome could develop in *tachinoides*, bred flies were placed in large cages containing the *Varanus* enclosed in rat cages. The

Fig. 1. *Trypanosoma grayi*-like flagellates in gut of *Glossina tachinoides* after feeding on *Varanus*. Drawn with Abbé drawing apparatus, × 2,000.

flies lived well and in some cases produced larvae. In all, 41 land *Varanus*, of which 23 were proved to harbour *T. varani*, were exposed to the flies, which were dissected at intervals of from 2 to 26 days after first feeding on the monitor. Of 188 flies thus

examined, 186 proved negative. The remaining two had heavy flagellate infections of the mid gut, and these were indistinguishable from the crithidia of *T. grayi*. The two flies occurred in a series of seven which had fed for six days on four land *Varanus*. No trypanosomal forms were seen, but such only occur in the most massive infections of *T. grayi*, and these two were early infections of at the most six days' duration. They are illustrated in fig. 1. If such forms were encountered in wild flies they would be identified at once as *T. grayi*.

A series of bred *tachinoides* were enclosed in a similar manner with a water *Varanus* and were dissected after an interval of from 2 to 13 days from the first meal. In all, 24 flies were dissected and no infections were discovered in them.

Certain frogs and toads harbour *T. rotatorium*, a trypanosome of similar type to *T. kochi* and *T. varani*. This species, or one very nearly allied to it, was found in the common species of toad (*Bufo regularis*, Reuss). It was found in all the adults examined, but not in the very young, and when present was numerous, two or three being seen in any coverslip preparation of unspun blood. With some difficulty bred *tachinoides* were induced to feed on these toads, the mouths of which were tied. The mortality of the flies was great, and only 20 to which the toads had been exposed for from 1 to 8 days were obtained for dissection. Of these no less than 11 had flagellate infections of the mid-gut. The flagellates were all short broad flagellated crithidia and showed no definite character which would serve to distinguish them from those seen in light *T. grayi* infections, but as fig. 2 shows, no large undulant crithidia, which are generally prevalent in *T. grayi* infections, were seen.

Fig. 2. *Trypanosoma grayi*-like flagellates in gut of *Glossina tachinoides* after feeding on a toad. Drawn with Abbé drawing apparatus, × 2,000.

The onset of the harmattan season with its difficulty in keeping the flies alive in the laboratory put a stop to these experiments. They were, however, sufficient to indicate that *T. grayi* may be obtained from the crocodile and in some cases from *Varanus* and possibly other animals. They also seem to indicate that *T. grayi* may be a group name and not that of one definite species of flagellate.

VIII. Seasonal Fluctuation of Infections.

In contrasting the flies at the various foci one with another the proboscis infections were treated as an entity for convenience in the comparison. *T. vivax* greatly predominates in them, not only because it is the trypanosome which most readily becomes established in tsetse, but also because it undergoes all its development in the proboscis, so that in dissection by this method all its immature infections are discovered.

In the case of *T. congolense* the interval between the invasion of the labial cavity and the maturing of the infection is brief, and the corresponding interval in the salivary glands in the case of the *brucei-gambiense* group is also brief (estimated by Miss Robertson as 2-5 days in *G. palpalis* infected with *T. gambiense* (5). Consequently few of the immature infections of these groups are discovered by the rapid method of dissection. The rise and fall of the proportion of proboscis-infected flies is therefore mainly due to the increase or decrease of *T. vivax*. An analysis of the mature infections of *T. vivax* and *T. congolense* in the two species of fly over the whole area is given in Table VI and Diagram 5.

TABLE VI.

Showing Percentage of Fly from Various Localities about Sherifuri which showed Mature Infections with T. vivax *and* T. congolense.

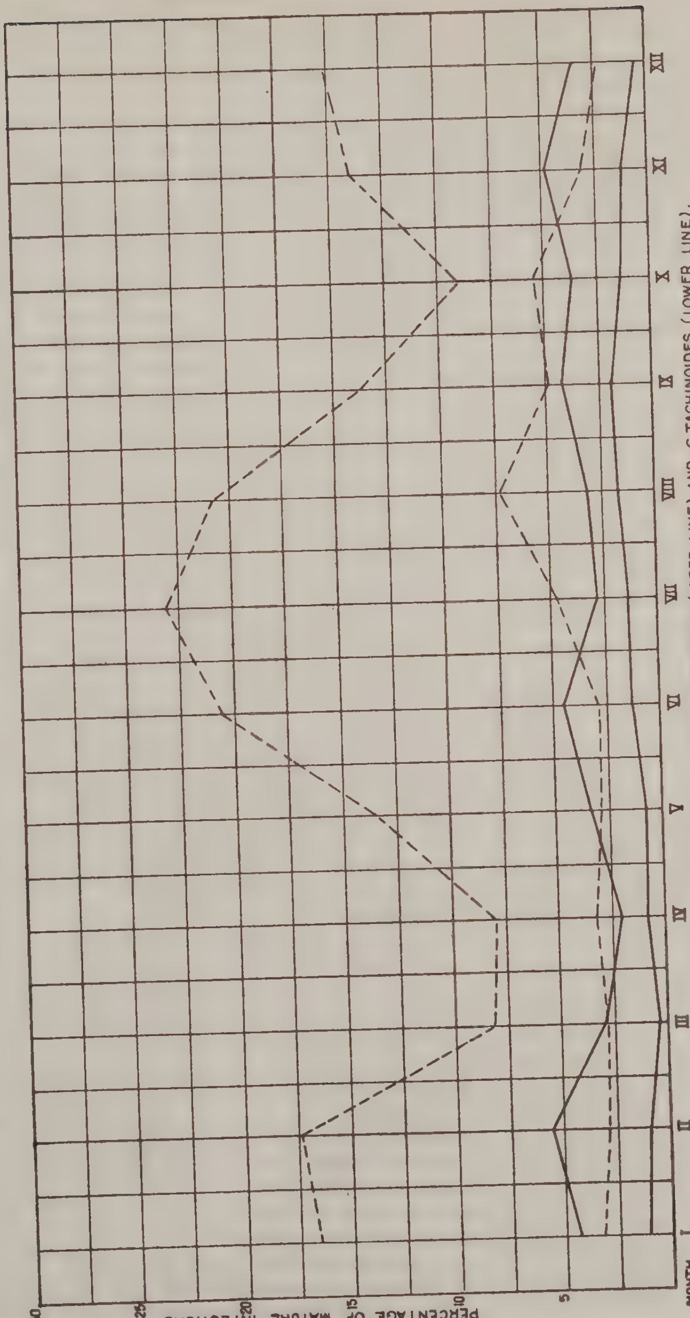
Month.	*G. morsitans.*			*G. tachinoides.*		
	Number dissected.	Mature *T. vivax.*	Mature. *T. congolense.*	Number dissected.	Mature *T. vivax.*	Mature *T. congolense.*
January ..	400	16·5	4·3	772	3·1	1·2
February ..	420	17·4	5·5	550	2·7	0·9
March ..	435	8·1	2·7	930	2·6	0·3
April ..	400	8·0	2·0	650	3·2	0·9
May ..	350	13·4	3·4	650	2·8	0·6
June ..	380	20·5	4·5	670	2·8	1·3
July ..	500	23·0	2·8	700	4·7	1·4
August ..	600	20·7	3·2	1,100	7·4	1·7
September..	600	13·7	4·2	1,060	4·7	1·8
October ..	600	9·2	3·7	1,450	5·4	1·5
November	690	13·8	4·8	1,220	3·1	1·2
December ..	516	15·1	3·5	1,047	2·4	0·5
Total ..	5,891	15·1	3·7	10,799	4·2	1·2

The mature infections of *T. vivax* in *morsitans* are high in January and February (16–17 per cent.) and fall to a minimum of 8 per cent. in the two following months, which are the hot months of the dry season. There is then a steady rise to the high figure of 23 per cent. in July, and this is followed by just as sharp a fall to 9 per cent. at the end of the rains in October. There is a further rise in the early part of the dry season to 15 per cent. in December. The infections of *T. congolense* are more constant through the year, but show a well marked fall in March and April corresponding to that of *T. vivax* in the same period.

The mature infections of *T. vivax* in *tachinoides* show little fluctuation through the later dry season, varying less than 1 per cent. from January to June. There is then a sharp rise to 7·4 per cent. in August corresponding to the rise in *morsitans*. This is followed by a fall to about 5 per cent. in September and after a slight rise there is a sharp fall to the dry season level of 2·5 per cent. in December. The infections of *T. congolense* show the same tendency to fall through the dry season and to rise through the rains, the maximum infection of 1·8 per cent. in September being as much as six times the minimum of March.

In our last report was given an account of the proboscis infections of *tachinoides* in the wet season around Mashiwashi in South Sokoto. It was shown that at the beginning of the rains only some 25 per cent. of the infections detected were mature, and that as the rains advanced this proportion increased till it reached 93 per cent. mature in October, when the rains ceased. The figures for *T. congolense* were low

DIAGRAM V. ILLUSTRATING THE SEASONAL VARIATION OF INCIDENCE OF TRYPANOSOME INFECTION OF G.MORSITANS AND G.TACHINOIDES AT SHERIFURI.



INTERRUPTED LINES = MATURE INFECTIONS WITH T. VIVAX OF G. MORSITANS (UPPER LINE) AND G. TACHINOIDES (LOWER LINE).

CONTINUOUS LINES = MATURE INFECTIONS WITH T. CONGOLENSE OF G. MORSITANS (UPPER LINE) AND G. TACHINOIDES (LOWER LINE).

and erratic, but those for *T. vivax* showed definite tendencies. The percentage of mature *T. vivax* infections was low (3·0 to 4·0 per cent.) in June and rose by August to 10·6 per cent. In September it fell to 7·5 per cent., and in October, when the rains ceased, rose again to 11·0 per cent. The infections of *T. vivax* here thus showed the same general tendency as they have done at Sherifuri.

It is clear that the fall in infection in the dry season is due to the dilution of the old flies with young ones which have as yet had little opportunity of acquiring infection. It should be noted that the fall in *morsitans* comes later than the fall in *tachinoides*, since the former fly starts breeding later. In *morsitans* the prelude to rapid breeding is an increase in food owing to the increasing availability of the wild ungulates. Consequently there is the rapid rise in infection which precedes this fall. In *tachinoides* the stimulus to rapid breeding at Sherifuri is given rather more by reptilian blood than by that of ungulates, and so there is no marked rise in infection before the fall due to the breeding except in the two localities where in September the mammalian blood in the diet was in excess of the reptilian blood. In general, however, the actual number of infected flies is increasing through the dry season, but as it is possible to estimate only the proportional infection this fact is usually masked in the breeding season by the large proportion of young flies examined. There are several instances in Table IV where, owing to a sudden change of food from reptilian to mammalian blood or to some sudden increase in the availability of antelope, the rapid breeding fails to mask this increasing infection in *tachinoides*.

With the onset of the rains and the cessation of breeding, or at any rate its great reduction, the proportion of infected flies rises steadily through the months when the grass is still short and the antelope and pig are still easily accessible. The fact that the ratio of mature to total infections is increasing shows that fewer and fewer fresh infections are being acquired. This ratio reached its climax (76 per cent. for *tachinoides* and 80 per cent. for *morsitans*) at Sherifuri in the last months of the rains, as it did at Mashiwashi. Before this, however, the proportion of flies carrying mature infections of *T. vivax* is being reduced, and this can only be the result of established infections dying out during the later rains. Degenerate clumps of amorphous organisms are in fact often detected in the proboscides at this time. This must be due to the vitality of the *T. vivax* organisms in the proboscis being dependent on the fly obtaining fairly frequent blood meals, which may nourish the flagellates directly or indirectly through the secretions of the insect. Support to this view is given by the fact that the nutrition of *tachinoides* in the rains fell to a low point (less than 20 per cent. with recognisable blood) in one month of the rains only, and it was in the next month that the fall in the *T. vivax* infections took place. This is for the whole area, but the Eastern Pond forms a curious exception. Here the recognisable blood in the fly fell to a low point (below 20 per cent.) from July to September, and the infections fell also for these three months. Again the nutrition of *morsitans* fell to a similar low ebb for three months, and the fall in infection was of three months' duration, beginning in the second of the hunger months. That hunger in the fly should so affect organisms established in the proboscis only and not appreciably those which are also established in the gut is easily understandable. Laboratory evidence on these points is difficult to obtain, as frequent meals are necessary to keep the flies alive in captivity. Miss Robertson, however, notes that when *G. palpalis* infected with *T. gambiense* is starved for " any considerable interval " the trypanosomes in the proventriculus ebb back to the middle part of the gut and only gradually recapture their anterior position after the fly has fed (5).

The dry season rise in the infection of *morsitans* coincided with the early partial burning of the grass and occurred very definitely in the last week of October. Whether delayed burning would have postponed the increase in food which resulted firstly in this rise in infection and ultimately in the onset of rapid breeding it is not possible to say. In this connection it seems worth while to collect the following observations. In our first report we noted that on Baro Hill, a long-grassed laterite

plateau with a fair quantity of the larger antelope, near the end of the rains *morsitans* was in good condition and fat, whereas *tachinoides* seemed to be starving, there being no surface water here for crocodiles or monitor lizards. Having observed in the country generally that in the dry season *tachinoides* was only found where the shade was sufficient to prohibit in places the growth of long grass or a continuous undergrowth of dense shrubs, we attributed the condition at Baro to *tachinoides* being less able to nourish itself in the season of long grass than *morsitans* is able to do. Secondly, at Dau, towards the end of the dry season in March, we encountered a heavily forested small valley in which the grass had just been burnt. There was much game in the neighbourhood and many baboons. We considered that it was improbable that the water *Varanus* was present and that crocodiles were certainly not present. Here *tachinoides* was in a thriving condition and *morsitans* was starving, the flies being thin and a very high proportion of females (44 per cent.) being caught. At the time of our short visit we thought this state of affairs was produced subsequent to the fire owing to the game leaving temporarily. It seems probable now that the starving condition of *morsitans* was due to the grass having remained long far into the dry season owing to the late burning. Thirdly, in the neighbourhood of the Benue River, where the climate is dry and there is plenty of game but local conditions cause the grass to be burnt late in February, *morsitans* is excessively scarce and for the most part is not found, though it exists in quantity some miles from the river both to the north and south. Fourthly, at Mashiwashi, which is at the edge of a forest reserve, the grass had not been burnt in the previous year and was burnt in the year of our arrival. Here there was abundant game, but *morsitans* was scarce, and it was often difficult to obtain sufficient for experimental purposes without sending nearly to the southern limit of the reserve for the flies. There is also an interesting case quoted by Duke (6) in Uganda in 1916–17 when the rinderpest spread coincident with an unusually heavy rainfall. After the rinderpest at one spot he found *morsitans* much reduced in numbers, as it was generally after the great rinderpest spread of 1896. He gives the meteorological returns of several years, and these show that in the year of the spread of the disease 12·6 inches of rain fell from December to February, which is normally the driest season of the year, as against 5·8, 6·8 and 4·2 inches for the two preceding and the following year. This must have affected the grass conditions. It had been suggested previously that the reduction of *morsitans* in the great rinderpest spread of 1896 might be due to unusual climatic conditions, since it was by no means certain that the reduction of the game, though great, was sufficient to account for the disappearance of the fly over large areas. After this suggestion was made Jack (7) collected some meteorological returns from South African recording stations and these indicated no unusual rainfall. There is, however, something about endemic and spreading rinderpest, or the causes of which these disease conditions are the results, which is unfavourable to *morsitans*. Is rinderpest endemic in any area where there is a sufficiently prolonged dry season to allow of grass burning and a subsequent long period of short grass? Is *G. morsitans* found in any area where there are two rainy seasons in the year? No doubt Veterinary Officers or other observers in East Africa could answer both these questions.

There is just a little evidence that late burning of the grass shortly before the rains begin may interfere with the free breeding of *morsitans*, and in some cases that of *tachinoides* also. Swynnerton considers that late burning of the grass would be of value in the control of tsetse as affecting their shelter, and this measure has already been strongly recommended in East Africa. We propose to test the effect of late grass burning from this other point of view. The systematic examination of both species of fly will be continued at various points here and in the next dry season; two large parts of the area will be protected from burning till just before the commencement of the rains, while a third part will be burnt early as a control. This experiment should afford definite information as to whether controlled grass burning can affect, firstly, the infection, and, secondly, the breeding of the flies.

We also propose to carry out the often recommended experiment of excluding the game animals from one part of the area, and the definite dry season focus of *morsitans* and *tachinoides* at the Eastern Pond will be surrounded by a strong wire fence and the game animals driven from it. There is no need to recapitulate here the well-known arguments for and against this course. The extreme condition which it is expected to produce will be very artificial and admittedly unattainable rapidly in nature. It cannot fail to give information which will be of value, and we consider that the experiment will be justified here, as by the time the fence is constructed we shall have collected for a period of two years figures relating to the infection, food and breeding of the two species of fly in the fenced and in control areas for comparison with statistics obtained subsequent to the fencing.

IX. Summary.

This report contains a record of the trypanosome infections, food and breeding of *G. morsitans* and *G. tachinoides* obtained by examining the flies at various foci over a period of fourteen months.

It confirms the fact that the breeding of both species is practically confined to the dry season and follows a period of increased food supply. *G. tachinoides* is well fed through the rains, except in one month of flood, and starts breeding as soon as the rains cease, owing to its habit of feeding on reptiles. *G. morsitans* starts free breeding about six weeks later, as its increased food supply is due to the ungulates becoming more available.

G. morsitans does not feed on reptiles, but in times of hunger draws a proportion of its food from birds, the largest proportion recorded being 17 per cent. in one month at one focus. It draws the bulk of its food in this locality from small antelope, large game being scarce. *G. tachinoides* is much less specialised in its diet, and in the wet season nearly one-fifth of its food was drawn from a group of animals which included man, monkey and dog.

The infection of the flies with *T. vivax* and *T. congolense* bears a close relation to the amount of blood obtained from antelope, and consequently *morsitans* is in general nearly four times as heavily infected as *tachinoides*. Infections with *T. brucei* and *T. gambiense* are scarce in this locality. Trypanosome infection rises just before the main breeding season in *morsitans* in all localities and in *tachinoides* in places where the fly is largely a mammal feeder. The proportional infection in general falls in the season of most rapid breeding, owing to masking of the actual rise by the number of young flies examined. It rises rapidly when breeding ceases. The total infection is reduced when fly food is hard to obtain, in the time of long grass and flood, owing to *T. vivax* infections dying out when the flies are starved.

It is shown that in some cases *T. grayi* may be obtained by *tachinoides* when it feeds on *Varanus*, and a somewhat similar infection in the laboratory may be obtained by feeding the flies on toads.

There is just an indication that postponement of grass burning may interfere with the free breeding of *morsitans* and in some cases that of *tachinoides*. This possibility is to be tested.

The experiment of excluding game and pig from one of the dry season foci of the flies by means of fencing will be carried out.

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To Hadeija
Tuminjera
Kiyawa River
Kiyawa River
Old Aulami
Kiyawa River
Babuwuri
New Aulami
Siti
Bakar Kuka
Lafiyari
Jemaari River
Tulu (deserted)
R. Malele
Broad Pond
Camp
Sherifuri
Market
R.H.
N
Dumugu
R. Malele
Eastern Pond
Village Pond
Galdimari
Sand Ridges thus
Baobab Bush uncoloured
Long-grassed Plain thus
Heavy Deciduous Forest thus
Localities whence Tsetse collected thus - X Broad Pond
Galedebu (deserted)
Main Road Pond
MAP OF
SHERIFURI DISTRICT
Jemaari River
South Bank of Main River
Scale of Miles.
0
1
2
3
Scale 1:50,000.
To Azare
John Bale, Sons & Danielsson, Ltd

SODIUM FLUORIDE AS AN INSECTICIDE; ITS POSSIBILITIES AS A LOCUST POISON.

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The purpose of this paper is to direct attention to the possibilities of sodium fluoride as an insecticide. Recent investigations of this salt as a stomach poison, which I have undertaken with cutworms and locusts, as well as its few but successful previously known uses as an insecticide against fowl-lice, Mallophaga on mammals, cockroaches, and earwigs, indicate that sodium fluoride may, in a number of cases, replace the use of arsenical poisons. During the past decade the use of arsencial insecticides has increased rapidly. We are at present threatened with higher prices and possibly with a shortage of arsenic, a situation accentuated by the present cotton-boll weevil programme of the United States of America, which involves the use of tremendous quantities of arsenicals. Any cheap stomach poison effective against insects and promising as a substitute for arsenicals should therefore be of considerable interest to the entomologist and to the farmer, especially if it carries the additional advantage of being considerably less poisonous to man, stock and birds. Sodium fluoride meets these requirements.

The chief source of this salt is the mineral cryolite, an aluminium-sodium fluoride, one of the principal aluminium ores. By treatment of cryolite with caustic soda the aluminium fluoride is dissolved out, leaving sodium fluoride, which is mainly, then, a by-product of the aluminium industry. It is also a by-product in the extraction of other metals from certain ores. Its production as a by-product together with its limited use account for the low price of the salt. Before the late war it sold for 4d. per lb. in England. At the present time but small quantities are available in South Africa, the prices varying to a marked degree but comparing favourably with those of arsenite of soda and arsenate of lead. If used in large quantity in the country, sodium fluoride could most probably be sold more cheaply than are arsenicals at the present time.

This substance is sold in the form of a rather fine white powder. Samples of the commercial product analysed by Mr. C. O. Williams, Lecturer in Chemistry, Cedara, yielded 95 per cent. NaF (sodium fluoride). The chemically pure product can be obtained but has no advantages over the commercial powder for insecticidal purposes. An adulterated form containing 60 per cent. common salt has been found on the market in America. A saturated aqueous solution of NaF contains 4·3 per cent. of the salt at 18°C., the solubility increasing but slightly with the temperature. Of the 5 per cent. impurities contained in the commercial product, 90 per cent. was dissolved upon shaking for a half-hour in cold water. Hard water cannot be used in making solutions of a prescribed strength unless extra amounts of NaF be added, since insoluble calcium fluoride is formed. Sodium fluoride is closely related chemically to common salt, containing fluorine instead of chlorine. It is a comparatively stable compound, requiring no especial care in shipping or storing.

It is not generally classed as a poison. Taken internally it acts as a strong local irritant, causing vomiting. Several small doses are more injurious than one large dose. A 15 grain dose is reported to have killed a 20 lb. dog in four days. I have been unable to learn the dosages required to kill other mammals or birds, but the available evidence indicates that ordinary use in the field would not be at all dangerous. It is certainly very much less toxic than arsenic to higher animals, since ½ to 1 grain of arsenite of soda is the lethal dosage for a dog. A healthy fowl was allowed to feed at will for three days exclusively upon locusts which had died of sodium fluoride

poisoning. She ate about a hundred of them, but remained apparently unaffected in any way. Certain poultry spices in general use contain sodium fluoride in large quantity. It acts as an irritant upon the ovaries, and it is said to increase egg-production. It has been used as a bactericide in treating phthisis in man in doses of one-twentieth to half a grain.

Besides these limited uses just mentioned and its common employment as a flux in mineralogical analysis and as a preservative, notably in beers and wines, there remains known to me only the use as an insecticide. Its value in this respect is by no means well known even by entomologists. Poultry growers have found it effective in dusting fowls for lice. Mr. T. B. Cross, Lecturer in Poultry, Cedara, informs me that he has used it with excellent results. I believe that it acts as a contact poison as well as a stomach poison on these Mallophaga, since many of them drop off immediately. Its use has also been advised in treating dogs for biting lice. Strangely enough, none of the several works on poultry pests which I have consulted, one of them recent and comprehensive, mentions sodium fluoride, nor do most of the well-known reference books on economic entomology. Its use against cockroaches has been favourably reported upon, the powder diluted with an equal amount of flour being scattered over floors, benches, etc. Mr. C. P. Lounsbury, Chief, Division for Entomology, has advised its trial for crickets in houses, against which pests it would probably prove effective. It has given good results as a contact dust against the Argentine ant and the household silver fish insect (*Lepisma* spp.). Moth-bait has been poisoned by it. The most thorough work known to me on sodium fluoride was carried on in America in 1923 with the European earwig (Fulton B.B., Jl. Econ. Ent., xvi, No. 4, pp. 369–376, Aug. 1923), a minor American pest. The worker demonstrated by a series of conclusive experiments that sodium fluoride is as effective a stomach poison as white arsenic against this earwig and that it acts more quickly. This work demonstrated beyond a doubt the value of this salt as a stomach poison.

During an extensive study of cutworm baits which I have been pursuing during the past year, I determined that arsenite of soda acts strongly as a repellent (a fact previously noted by Mr. R. W. Jack, Chief Entomologist, Rhodesia, who used different methods) and that the same applies to Paris green to a lesser extent. Of a dozen or more poisons investigated sodium fluoride was the only one combining high toxicity with slight repellent action. Bait treated with a 1 per cent. solution gave a lethal dose in a few minutes' feeding, death occurring usually within two days' time as a result of the effect of the fluorine ions on the epithelial cells of the mesenteron. (A detailed account of this work is to be published later.)

The fact that earwigs and cockroaches could be poisoned with sodium fluoride suggested that locusts, closely related to both, might be similarly affected, especially since such distantly related groups as cutworms and fowl-lice were readily killed by it. For the purpose of determining its toxicity to the brown locust I carried on a series of laboratory experiments at the Glen School of Agriculture, O.F.S., where flyers were abundant during January 1924. Unfortunately voetgangers could not be obtained at the time, the work being done only with the adults.

In order to obtain accurate data in this type of investigation, I have found it necessary to deal with isolated individuals rather than follow the usual method of treating with large numbers in large cages. The individuals were handled singly in small wire-mesh cages and fed daily, the amount eaten by each one being recorded. Four different means of applying the poison were employed :—(1) grass (*Cynodon dactylon*, Pers., unless otherwise specified) dipped in solution and the surface slowly dried, using 1 per cent., 1½ per cent. and 2 per cent. solutions ; (2) grass dusted with the powder diluted with lime 1 to 50 by weight ; (3) bait made of fresh horse-dung moistened with 2 per cent. solution ; (4) dust 1 to 20 applied to locusts kept without food to test its effect as a contact insecticide. Arsenite of soda was used with grass and bait to compare its effects with those of sodium fluoride. All experiments were

accompanied by corresponding controls, keeping the sexes in about equal numbers throughout. Space does not permit the publication of all the tables prepared. The results obtained with each of the four methods will be discussed in the order named.

1. *Grass poisoned by Solution.*

Table I shows the effect of a single dose of 1 per cent. NaF upon previously well-fed locusts. The poisoned grass was left in the cages 24 hours, unpoisoned grass being supplied daily thereafter. About 65 per cent. had died by the end of the third day after poisoning, others not until the 4th, 5th and 7th days, when, as will be seen by a glance at the Control Table, they might have died of other causes. The males, as in all of these experiments, were poisoned more readily than the females. Table II shows the effect of two doses of 1 per cent. NaF. The individuals were fed with poisoned grass three days in succession. Only one of this lot received three doses, the rest refusing to feed on one or another of the three days. This reluctant feeding was due to the fact that Kikuyu was used, a grass not readily taken by well-fed locusts. The day after the second dose was taken 70 per cent. died ; the remainder were all dead on the third day. It is apparent from these results that the amount of NaF taken by a well-fed locust in one " meal " at this strength is not sufficient to give a satisfactory killing. A later experiment with individuals starved for two days gave similar results.

In a similar experiment using 1½ per cent. seven of eight locusts died by the third day, only one in the control (eight individuals) dying during this time.

Satisfactory results were obtained with 2 per cent solution. Well-fed locusts all died by the third day after taking one " meal " of the poisoned grass, 78 per cent. dying by the second day, as shown in Table III. Of those receiving two doses nearly all died on the day after the second dose was taken. A number of other similar experiments with 2 per cent. gave equally good results. An experiment designed for comparing the effect of 2 per cent. arsenite of soda with that of NaF of the same strength showed that the former was more toxic, since it acted more quickly (Table V).

Locusts having received a lethal dose usually feed normally until a few hours before death, a habit which renders observation of the effect of the poison very misleading before sufficient time has elapsed to allow its action to become apparent. Cutworms poisoned with NaF, on the other hand, seldom feed at all after a lethal dose has been taken ; feeding after poisoning nearly always indicates recovery.

2. *Dusted Grass.*

Grass dusted with a mixture of NaF and lime, 1 to 50 by weight, was fed to twelve individuals for one " meal " followed by untreated grass. One died on the first day, five on the second, and six on the third. In the control experiment, grass treated with lime only, one died on each of the first two days, four on the third, and five on the fourth. The toxic effect was very apparent, but it is uncertain whether this strength would be satisfactory for use in the field. Both dusts have a marked repellent effect, the dusted grass being less readily taken than the dipped, the latter having no apparent repellent action.

3. *Horse-dung Bait.*

One quarter of a lb. of fresh horse-dung moistened with 50 cc. of 2 per cent. NaF was taken readily, giving satisfactory results. Of eighteen individuals, nine of each sex, allowed to feed on this bait during one day all died by the third day, only four dying in the control (fed on untreated horse-dung for one day) during this time. In a similar experiment with bait made in the same way, using arsenite of soda 2

per cent. with one lot of individuals and NaF 2 per cent. with another lot, the former was found to kill somewhat more quickly (Table VI). A reaction experiment showed that grass was preferred to fresh horse-dung.

4. *Dust as a Contact Poison.*

Twenty-eight locusts were dusted thoroughly with NaF and lime, 1 to 20 by weight, and the same number with lime alone, using a duster made by attaching a rubber bulb with a valve to an ordinary wash bottle. This apparatus proved excellent for the purpose. The dusted locusts were left unfed in order that the stomach-poison factor should be eliminated. Although carefully observed they were not seen to go through any movements, such as cleaning the antennae, etc., which might introduce the poison into the mouth. Results were entirely negative. A few individuals dusted with pure NaF, however, died in a few hours. If the dust acts as a contact poison at all it is only when used much stronger than 1 to 20.

These experiments, however incomplete, indicate strongly that adults of the brown locust could be killed in the field by spraying with 2 per cent. NaF solution or by baiting with horse-dung wet with 2 per cent. solution. The voetgangers in all probability would require a weaker strength ; probably 1 per cent. would suffice. The arsenite of soda and treacle poison as it is applied in the field contains roughly from ½ per cent. to 1 per cent. sodium arsenite. Apparently NaF would have to be used at twice this strength. If the advantages of handling a poison considerably less dangerous to man, stock, and birds than arsenite be entirely ignored, sodium fluoride, in order to compete with arsenite, must be procurable at half the price.

The fact should be emphasised that much more investigation along this line, as well as a considerable amount of field work, must be done before definite conclusions can be reached. This paper is intended merely to acquaint the reader with the possibilities. It is possible that NaF might be used effectively against the maize stalk-borer, fruit-fly, false codling moth, and other insects. Its effect upon foliage remains to be studied. During the coming year it is hoped that we may definitely determine its value in combating various insect pests.

Conclusions.

1. Sodium fluoride is effective as a stomach poison against cutworms and the brown locust.

2. It is not so toxic as arsenite of soda to either.

3. Grass or horse-dung treated with 2 per cent. solution of NaF gave good results against adult locusts in the laboratory.

4. Bait treated with 1 per cent. solution was effective against cutworms (*Euxoa* spp.) in the laboratory.

5. NaF is not repellent to cutworms. Arsenite of soda is highly repellent. Paris green repels to a lesser extent.

6. NaF dust probably does not act as a contact poison on adult locusts. If it does, strengths much stronger than 1 : 20 are required to act in this way.

7. NaF is considerably less toxic to higher animals than arsenite of soda.

8. It should be investigated further as a promising substitute for arsenicals against various insects.

TABLE I.

Grass treated with 1 per cent. NaF Solution. One Dose.

Sex.	No. of individuals.	Number dying each day beginning 24 hours after dose.						
		1st.	2nd.	3rd.	4th.	5th.	6th.	7th.
♀ ..	9	1	1	3	1	2	0	1
♂ ..	8	3	0	3	2	—	—	—
Total ..	17	4	1	6	3	2	0	1

TABLE II.

Grass treated with 1 per cent. NaF Solution. Two Doses.

Sex.	No. of individuals.	Number dying each day beginning 24 hours after 2nd dose. 1st dose either one or two days before 2nd dose.		
		1st.	2nd.	3rd.
♀ ..	5	2	1	2
♂ ..	5	5	—	—
Total ..	10	7	1	2

TABLE III.

Grass treated with 2 per cent. NaF Solution. One Dose.

Sex.	No. of individuals.	Number dying each day beginning 24 hours after dose.		
		1st.	2nd.	3rd.
♀ ..	10	3	4	3
♂ ..	8	1	6	1
Total ..	18	4	10	4

TABLE IV.

Control for Tables I–III.

Fed on untreated Grass.

Sex.	No. of. individuals.	Number dying each day.									
		1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.	10th.
♀	14	0	0	0	0	4	2	4	1	0	3
♂	14	0	0	2	0	2	2	3	4	0	1
Total	28	0	0	2	0	6	4	7	5	0	4

Table V.

(1) *Grass treated with 2 per cent. NaF Solution. One Dose.*

Sex.	No. of individuals.	Number dying each day, each beginning 24 hours after dose.						
		1st.	2nd.	3rd.	4th.	5th.	6th.	7th.
♀ ..	6	3	2	0	0	0	0	1*
♂ ..	6	3	3	0	0	0	0	0
Total ..	12	6	5	0	0	0	0	1*

* Very small dose.

(2) *Grass treated with 2 per cent. Arsenite of Soda Solution. One Dose.*

♀	6	6	—	—	—	—	—	—
♂	6	6	—	—	—	—	—	—
Total ..	12	12	—	—	—	—	—	—

(3) *Control.*

♀ ..	12	1	2	0	1	0	2	2*
♂ ..	12	1	3	1	1	1	2	2*
Total ..	24	2	5	1	2	1	4	4

* Rest alive on 10th day.

Table VI.

(1) *Horse-Dung moistened with 2 per cent. NaF Solution.*

Sex.	No. of individuals.	Number dying on each day beginning 24 hours after dose.			
		1st.	2nd.	3rd.	4th.
♀ ..	7	5	2	—	—
♂ ..	8	5	1	1	1
Total	15	10*	3	1	1

* Died five in morning and five in afternoon.

(2) *Horse-Dung moistened with 2 per cent. Arsenite of Soda Solution.*

♀	8	5	2	1	—
♂	9	7	1	1	—
Total	17	12*	3	2	—

* Died all in morning.

A NEW LONG-HORNED GRASSHOPPER DAMAGING COCONUT PALMS IN NEW BRITAIN.

By B. P. Uvarov,

Assistant Entomologist, Imperial Bureau of Entomology.

Habetia defoliaria, sp. n.

♂. Pale greyish stramineous. Antennae clothed with short hairs, and with indefinite brownish rings. Face smooth. Fastigium of vertex cylindrical, sulcate above, with the apex rounded, and slightly inflated, viewed in profile almost truncate. Pronotum callosely rugulose ; its disc very feebly saddle-shaped, with the median carina scarcely perceptible near the hind margin, which is roundly truncate ; the two transverse sulci deep, the anterior one feebly bisinuate, the posterior one broadly arched ; anterior margin rounded ; lateral lobes sloping, somewhat longer than broad, with the anterior angle obtuse, the posterior one very obtuse and rounded, and the hind margin strongly sinuate, with a deep humeral sinus. Elytra nearly twice as long

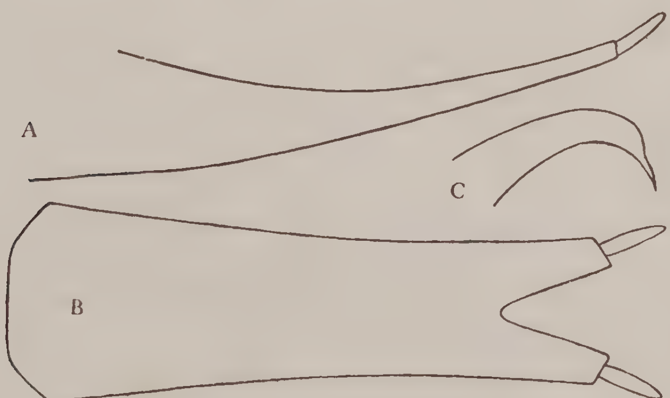

Fig. 1. *Habetia defoliaria*, Uvarov, sp. n., male genitalia : A, subgenital plate, side view ; B, the same, from below ; C, right cercus.

as the abdomen, with the veinlets whitish green. Prosternum armed with two not long, pointed, somewhat divergent spines. Mesosternal lobes small, rounded ; metasternal lobes forming together an equilateral triangle with the angles broadly rounded. Front and middle femora armed with 0–3 small black spinules on the inner lower margin (hind legs missing in the type). Cerci (fig. 1, C) round, feebly incurved, with the apex attenuate, distinctly incurved, pointed. Subgenital plate (fig. 1, A, B) very long and narrow, slightly recurved ; the lower surface almost flat, with an incomplete median ridge and two more distinct sublateral ridges running throughout the plate to the bases of the styli ; the latter short, cylindrical ; hind margin of the plate acutely and deeply excised between the styli.

♀ (paratype). Elytra pale green ; thorax, head and body as in the male. Hind femora with 6–9 irregularly placed spines on each side below. Subgenital plate

rounded-traingular, with the apex acutely emarginate. Ovipositor as long as the hind femur, gradually narrowed apically; its upper margin practically straight and the lower margin very gently curved.

	♂ (type).	♀ (paratype)
Length of body	39 mm.	49 mm.
Length of pronotum	7·5	8
Length of elytra	50	53·5
Length of hind femur	—	36
Length of subgenital plate	10·5	3
Length of ovipositor	—	34

New Britain: Rabaul, 1 ♂, 1 ♀ (*H. W. Simmonds*).

Mr. Simmonds writes that in two or three places in New Britain he saw coconut palms that had been completely defoliated by these grasshoppers.

The species is the fourth known in the genus *Habetia*, the three previously described being all from New Guinea. It is easily recognised by its male genitalia, while the female differs from the only species in which this sex is known (*H. spada*, Br.W.) by its much shorter ovipositor.

THE TREATMENT OF SMALL BATCHES OF COTTON SEED AGAINST PINK BOLLWORM.

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In connection with the development of cotton growing within the Empire, it has been found necessary to circulate many small batches of experimental cotton seed; and as a number of these batches pass through this country, it has been deemed advisable to disinfect them against pink bollworm (*Platyedra gossypiella*, Snd.) and other insect pests.

Gough and Storey in Egypt were the first to experiment on the destruction of the resting stage larvae of the pink bollworm within the cotton seed. They tried a large number of methods for disinfection and came to the conclusion that treatment by heat afforded the simplest and most sure method of dealing with the large quantities of seed that have to be handled in that country.

In dealing with small batches of seed in this country fumigation with carbon bisulphide vapour was used at first, but has now been replaced by heat treatment. For this purpose an ordinary anhydric electric oven was fitted with a number of perforated metal trays; the seed is spread in thin layers on the trays, allowing a considerable air space between the trays. In this way a small oven fitted with four trays measuring 9 by 12 in. will take 1·3 lb. (600 gms.) of white cotton seed at a time, and one may be sure of an equal heating effect throughout.

It was necessary to determine in the first place, how long, and at what temperature, the seed may be safely treated without endangering germination, and secondly what temperature is required to kill any insect that might be present.

Storey (6) in answering the same questions came to the following conclusions :—

" If the seed is maintained for five minutes or more at the temperature in question, the worms are killed at temperatures from about 52° C. upwards." And " provided that neither the whole mass of seed nor individual seeds are heated to a higher temperature during the treatment, dry seed can safely be raised to a temperature of 65° C. without damaging the germination." He also states (7) that no harm is done to germination at temperatures below 70° C.

Since this, a number of experiments have been carried out in various countries. All of these, however, dealt with large quantities of seed, and they gave apparently conflicting results.

Gough (3) in describing the use of machines on a commercial scale advises the use of temperatures between 60°–65° C.

Ballou (1) advises the use of 54·5° C. for 5 minutes and states that germination is not impaired by temperatures below 65° C.

Coelho de Souza (2) advises temperatures of 53°–56° C., which, he states, reduce the germination of the seed by about 15 per cent.

MacDonald (8) has found that the seed can be heated to 76·5° C. without damage, this treatment apparently improving the germinating quality. He found the thermal death point of *Platyedra* larvae to lie between 54·5° C. and 63° C. See also MacDonald (5) and MacDonald and Scholl (4).

In the present experiments the germination of the seeds was done between two pieces of felt, under warm conditions that were kept as constant as possible. Germination percentages were calculated on the fifth to the seventh, and on the ninth, days after the damping of the seeds. At the end of this period germination was found to be practically complete and the readings taken in this way indicate

whether the germination is accelerated or retarded even if the ultimate percentages be similar.

Both black and white seeds—*i.e.*, seeds with and without "fuzz"—were treated for periods varying from 0 to 24 hours, first of all at 57·5° C. and later at 60° C.

Expt.	Number and kind of seed.	Length of treatment (hours).	per cent. germinated on			
			5th	6th	7th	9th day.
	Initial temperature 57·5° C.					
1	157 mixed black and white ..	0	70·0	78·9	80·9	80·9
	212	3	63·7	81·1	84·9	85·4
	148	5	62·0	74·3	81·0	82·4
	184	24	37·5	54·9	58·1	60·3
2	138 white seeds	0	71·7	75·4	76·0	76·8
	164	20	56·1	68·9	71·9	71·9
	137	28	41·6	50·4	62·9	64·2
3	195 black seeds	0	75·4	77·9	77·9	77·9
	207	20	64·7	65·7	65·7	65·7
	194	28	69·0	74·2	74·9	75·3
	Initial tenperature, 60·0° C.					
4	557 white seeds	0	65·5	75·0	80·0	80·8
	525	5	73·6	77·9	80·5	81·7
5	220 white seeds	0	8·6	26·8	36·3	39·5
	293	24	4·1	29·0	35·8	35·8

Different batches of seed were used for each experiment and those used for Expt. 5 were very poor.

The results, although very variable, show quite definitely that the seed may be heated for as long as 28 hours without very much falling off in the germination.

In these experiments the temperatures 57·5° C. and 60·0° C. represent the internal temperature of the oven before the introduction of the seed. On introducing the seed, the temperature falls as much as 9° C., according to the mass of seed introduced, and then slowly recovers to within a degree or so of the original temperature.

The following tables indicate (1) the fall in temperature and (2) the period needed for the temperature to rise to within a degree of the initial temperature, using varying weights of white cotton seed, which naturally shows a slower temperature change than corresponding weights of black seed, without the poor conducting covering of "fuzz."

Weight in gms.	100	200	300	400	500	600
1 Fall in temperature ..	6·0°	5·6°	6·9°	8·0°	7·5°	8·7°
2 Period of recovery mins.	35	40	55	50	55	65

In the second place it was necessary to determine what temperature was required to kill the pink bollworm within the "double seeds." Owing to the difficulty of securing healthy specimens in this country, only a very limited number of tests were possible, but these were sufficient to indicate what treatment is necessary.

The tests were carried out in the oven, with the trays bearing their full complement of white seed, and with the temperature at 58–59° C. The double seeds were attached to threads and placed amongst the other seeds, care being taken in all instances to prevent actual contact between the double seeds and the metal trays, so that the conditions were the most favourable for the larvae. The seeds were then removed at intervals and the larvae examined during the following 24 hours.

In the following table the condition of the larvae is indicated as follows :— W, well ; I, indisposed ; S, sick ; M, moribund ; D, dead.

Length of treatment.	No. of larvae treated.	Condition of larvae after intervals of			
		½ hour.	3 hours.	12 hours.	24 hours.
mins.					
15	1	1 I.	1 I.	1 I.	1 W.
30	1	1 S.	1 I.	1 W.	1 W.
45	2	2 M.	1 S., 1 I.	2 I.	2 W.
60	1	1 D.	—	—	—
60	1	1 D.	—	—	—
60	4	4 D.	—	—	—
75	3	3 D.	—	—	—
105	1	1 D.	—	—	—

These results show quite conclusively that, with the initial temperature of the oven at 60° C., one hour's treatment is sufficient to kill all pink bollworm.

A few additional tests were tried on some adult Coleoptera of three species.

Specimens of *Tribolium* placed within hollowed-out white cotton seeds were killed in 5 minutes at 59° C. Similarly, adults of *Niptus* and *Anobium* were killed in 5 minutes, as also the larvae of *Alphitobius*. Adults of *Calandra oryzae*, although more resistant, were all dead within half an hour.

For the treatment of small batches of cotton seed in an anhydric electric oven, it is therefore recommended that the seed be heated for 90 minutes with the oven working at 60·0° C. This will ensure the death of all insect life and will not damage the germinating power of the seed.

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ON SOME NEW SPECIES OF COCCIDAE FROM VARIOUS SOURCES.

By E. Ernest Green, F.E.S., F.Z.S.

Genus **Alecanopsis,** Ckll.

This genus was founded to contain the single species—*filicum* of Maskell, which had been referred by that author to the genus *Lecanopsis.*

Maskell's original description of the species (Proc. Linn. Soc. N.S.Wales, (2) viii, p. 225, 1893) is as follows :—

" Adult female dark red-brown ; dorsum very convex, the height being nearly equal to the length ; ventral surface flat or slightly concave, with small patches of white cotton between it and the root ; margin elliptical, slightly flattened. Abdomen exhibiting a shallow cleft with the usual two dorsal lobes ; but the cleft is scarcely noticeable, being hidden by the dorsal convexity. Cephalic region comparatively smooth ; abdominal region conspicuously segmented. The body at gestation becomes full of eggs and partially developed larvae. Antennae short, rather thick, conical, with 6 short subequal joints, of which the last bears a few hairs. Feet also short, partly atrophied, the joints somewhat swollen ; claw very small. Rostrum moderate ; mentum monomerous.

" Habitat : Kurrajong Heights, New South Wales ; under ground, on rhizome and roots of *Woodia aspera.* Forwarded by Mr. A. Sidney Olliff."

Morrison (Proc. U.S. Nat. Mus., 60, 12, p. 83, 1922) has recently redescribed the species, partly from imperfect material in the Maskell collection and partly from material (supposed to represent the same species) in the collection of the U.S. Bureau of Entomology. In view of the fact (as shown below) that at least three distinct species of *Alecanopsis* occur in South Australia, this double source of origin (from distinct host-plants) is unfortunate. Morrison, moreover, does not indicate which parts of his description are referable to the Maskell material and which to the material collected by Mr. Koebele. It is possible that one of the three species that I am now describing may be equivalent to *filicum* ; but, as I have been unable to reconcile the characters with those given by Maskell and Morrison, I have treated all three as new species. It is curious that neither of the authors mentioned has given actual dimensions nor, indeed, any indication of the size of the insect with which they were dealing.

In the following key, which may serve to separate the several species, I have had to rely (for the characters of *filicum*) upon the descriptions furnished by Maskell and Morrison. I have had no opportunity of examining typical material of that species.

A. Dermal cells absent or inconspicuous.
- *a.* Stigmatic spines very small ... ... *filicum*, Mask.
- *b.* Stigmatic spines large ... ... *tenuis*, sp.n.

B. Dermal cells present and conspicuous.
- *a.* Cells large and crowded on dorsum : much smaller and widely spaced on venter ... ... *mirus*, sp.n.
- *b.* Cells small and widely spaced on both dorsum and venter ; the ventral slightly larger than the dorsal cells ... ... *grandis*, sp.n.

Alecanopsis tenuis, sp. n. (fig. 1).

Adult female dull, pale, greyish brown ; circular or very broadly ovate ; flattish or moderately convex. Abdomen not conspicuously segmented. Length 5 to 7·5 mm. Derm membranous, not densely chitinized. Antennae and limbs set in folds of the derm ; but, as the latter is colourless, this character is not conspicuous and may easily be overlooked. There are, however, some small, more densely chitinized areas associated with the bases of the limbs. No conspicuous post-oral fold. Antennae (fig. 1, *a*, *b*, *c*) rather slender ; conspicuously but irregularly

6–7-segmented ; the basal joint very irregular in form and more heavily chitinized ; 2nd and 3rd joints longest. Buccal apparatus situated on a level with the anterior spiracles, at a distance from the anterior margin of about one-fourth the total length of the insect. Limbs (fig. 1, *e*, *f*) small, moderately stout, confusedly segmented, the division between tibia and tarsus absent or obscure ; tarsal digitules slender, obscurely knobbed ; ungual digitules short, dilated. Stigmatic clefts (fig. 1, *d*) with three, relatively large, stout claviform spines (occasionally with two supplementary smaller spines) and a dense group of multilocular pores extending inwards to the respective spiracles, which are large, conspicuous and heavily chitinized. Margin of body with slender, spiniform setae, distant from each other by about their own length, closer in the immediate vicinity of the stigmatic clefts. Valves of anal operculum large, irregularly triangular ; the basal margin longer than the hinder margin ; the posterior extremity slightly produced and bearing several stout setae. Anal

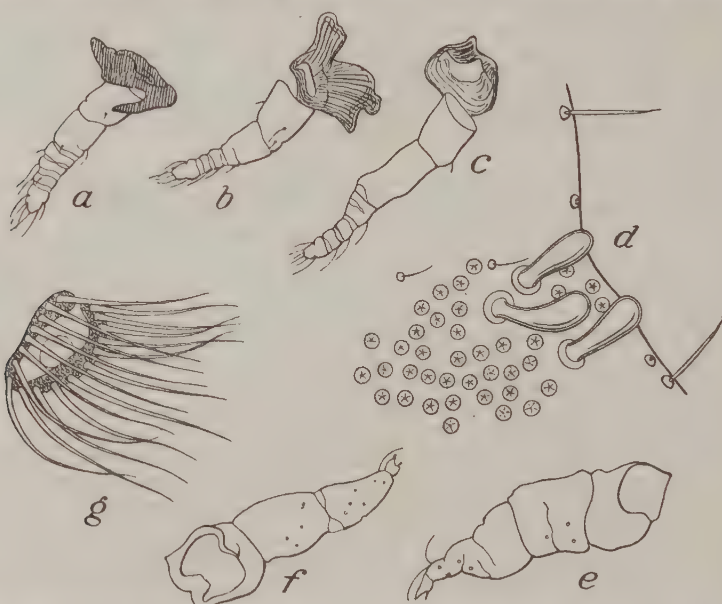


Fig. 1. *Alecanopsis tenuis*, Green, sp. n. : *a*, *b*, *c*, different forms of antennae, × 130 ; *d*, anterior stigmatic cleft and spines, × 450 ; *e*, first limb, × 220 ; *f*, third limb, × 220 ; *g*, anal ring and setae, × 220.

ring (fig. 1, *g*) rather heavily chitinized ; closely studded with small, circular, translucent cells and bearing from 18 to 20 (or more) long stout setae. Derm, of both dorsum and venter, sparsely set with minute setae ; a few longer setae and some small discoid pores on the venter, surrounding the genital aperture ; no noticeable dermal cells.

From hollows, caused by boring insects, in stems of *Banksia integrifolia*. Beaumaris, Victoria, Australia. " Attended by small black ants which construct a clay covering over the scales." Coll. C. French, jnr. (No. 132.)

Alecanopsis mirus, sp.n. (fig. 2).

Adult female (fig. 2, *a*) dull brown ; irregularly ovate, broadest across the mesothoracic area ; strongly convex above. Abdomen with deep transverse furrows

marking the junctions of the segments. Marginal area (more particularly that of the thorax) flattened and often rugose. Length 6·5 to 9 mm. Breadth, across thorax, 4·5 to 6·5 mm. Antennae and limbs partly concealed beneath heavily chitinized folds of the derm, forming shallow pockets (see fig. 2, *b*). This character is less noticeable in the early adult insects. Antennae (fig. 2, *c*, *d*, *e*) small and rudimentary; situated half-way between the frontal margin and the buccal apparatus; 3-jointed, the long terminal joint often exhibiting incomplete transverse divisions, varying in number from one to three, indicating that this segment is composed of several suppressed joints. Buccal apparatus far back towards the centre of the body; on a level with the anterior spiracles. Limbs (fig. 2, *f*, *g*, *h*) rudimentary, actually smaller than the antennae; trochanter and femur fused together, without trace of division;

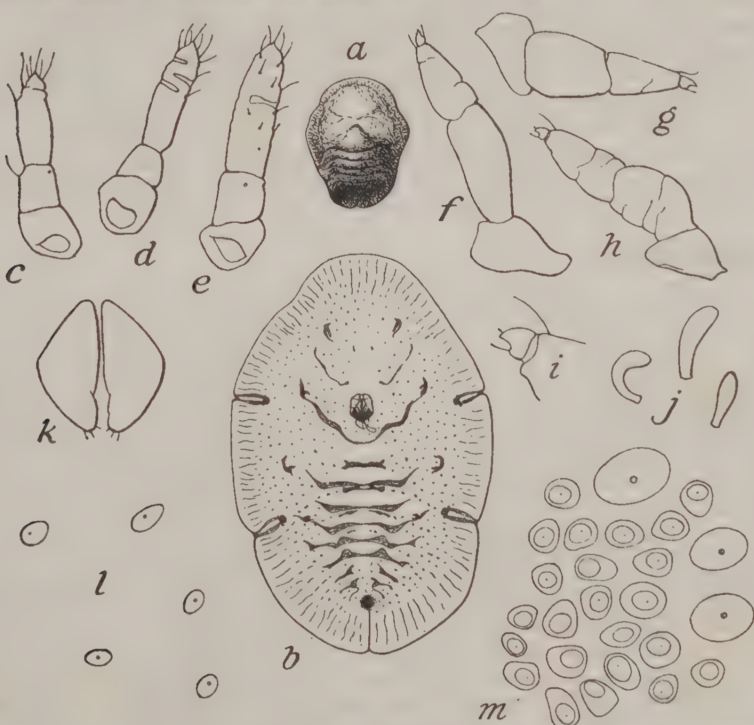


Fig. 2. *Alecanopsis mirus*, Green, sp. n.; *a*, adult ♀, dorsal view, × 3; *b*, adult ♀, optical section, × 9; *c*, *d*, *e*, various forms of antennae, × 130; *f*, anterior leg, × 220; *g*, mid leg, × 220; *h*, hind leg, × 220; *i*, foot of hind leg, × 450; *j*, stigmatic spines, × 450; *k*, anal operculum, × 80; *l*, dermal cells of venter, × 220; *m*, dermal cells of dorsum, × 220.

tibia and tarsus similarly fused, though there are often transverse folds simulating divisions. Claw (fig. 2, *i*) stout; the inner side of the base produced. Digitules small and inconspicuous; the unguals apparently narrowly dilated; the tarsals simple. Spiracles large and conspicuous, heavily chitinized; the anterior pair on a level with the buccal apparatus; the posterior pair at a distance from the posterior extremity of about one-third the length of the body. Stigmatic clefts well marked; the fundus densely chitinized and closely studded with multilocular pores; a loose series of similar pores extends inwards from each cleft to the respective spiracle (see fig. 2, *b*). Stigmatic spines (fig. 2, *j*) from one to three in each cleft, relatively

small, stout, claviform, straight or variously curved. Margin with short simple setae, at intervals equal to from five to six times their own length. Valves of anal operculum (fig. 2, *k*) bluntly triangular ; the outer angle broadly rounded ; the inner surface infolded all round, forming a denser thickened margin. Anal ring with numerous long, stout setae ; exact number not determined, apparently about 20. Derm of dorsum crowded with large and conspicuous cells (fig. 2, *m*), of which two forms are recognizable : some scattered, larger, regularly ovate cells which are wholly translucent, each with a relatively large, thick-rimmed pore in the centre ; and more numerous, deep-seated, irregularly ovate or circular or quadrate cells, each with a smaller, sharply-defined translucent area on the surface and with a minute central pore. Scattered irregularly over the inner surface of the derm of the dorsum are many heavily chitinized callosities, which are of a linear sinuous form on the marginal areas and irregularly circular on the median area. Derm of venter with much smaller and more widely spaced translucent cells (fig. 2, *l*), each with a small thick-rimmed pore in the centre. Heavily chitinized dermal folds mark the divisions of the ventral segments and cover the bases of the antennae and limbs. A moderately close series of multilocular pores surrounds the concealed genital aperture.

These interesting specimens were received through Mr. H. Donisthorpe, with the following data :—" From nests of *Cremastogaster australis*. Townsville, Queensland, Australia. Collected by F. P. Dodd, 1902."

Alecanopsis grandis, sp.n. (fig. 3).

Adult female reddish brown ; ovate, somewhat narrower behind, highly convex above, the abdomen deeply and conspicuously segmented. Anal cleft short and inconspicuous. Length 12 to 14 mm. Breadth across the middle approximately 8 mm. Antennae (fig. 3, *d*) situated shortly in front of the buccal apparatus, short, obscurely segmented, at most with three complete joints ; embraced by a densely chitinized dermal fold which partially conceals the basal joint. Buccal apparatus situated well forward, distant from the anterior margin by about one-sixth the length of the body ; surrounded (except in front) by a dense chitinous fold (see fig. 3, *c*) which includes the attachments of the first pair of limbs. Limbs small and much reduced (fig. 3, *e*), stout, tapering to the distal extremity ; segmentation obscure ; the basal parts concealed beneath densely chitinous folds. Claw stout, the inner side produced. Digitules apparently present, but difficult to see owing to the density of the derm. Spiracles obscured by dense dermal incrassations ; the two pairs widely separated from each other, the anterior pair at a level shortly behind the post-oral fold, the posterior pair at a distance from the posterior margin of approximately one-quarter the length of the body. Stigmatic spines (fig. 3, *h*) relatively small, stout, claviform ; situated in a densely chitinous band, which extends to the spiracle and is crowded with conspicuous funnel- or horn-shaped tubular pores (fig. 3, *i*). Valves of anal operculum obscurely lunate. Anal ring with many (more than 20) stout but relatively short setae. Derm of dorsum with relatively small, widely spaced, translucent cells (fig. 3, *f*), amongst which are a few slightly larger nucleated cells. Derm of venter with similar but rather larger cells (fig. 3, *g*), each with a conspicuous central pore, and with densely chitinous bands demarcating the intersegmental areas. Margin with a few inconspicuous simple setae.

Embryonic larva (fig. 3, *a*) of normal Lecaniid form. Length 0·5 mm. Antennae 6-jointed ; 3rd and 6th longest, approximately equal. Buccal apparatus large and dense. Limbs slender. Stigmatic clefts each with a single small claviform spine (fig. 3, *b*). Caudal setae long and slender, more than half the length of the body.

The material from which the foregoing description has been drawn up is from the collection of the British Museum (Nat. Hist.). It is labelled as follows :— " Reg. No. 1902–143. Portion of a fern rhizome infested with *Lecanopsis filicum* Mask., from the burrow of an ant (*Camponotus intrepidus* K.), Bundarra, N.S. Wales :

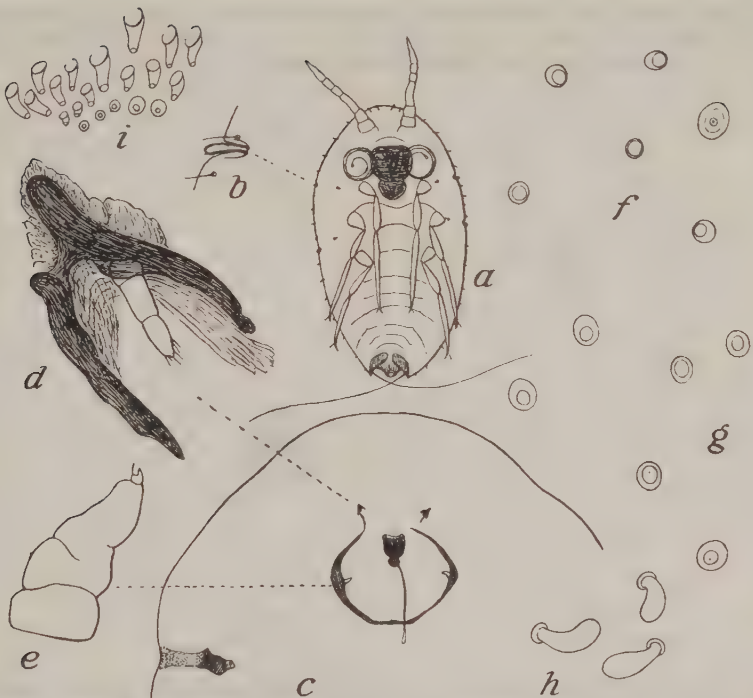


Fig. 3. *Alecanopsis grandis*, Green, sp. n., ; *a*, embryonic larva, × 80 ; *b*, do., stigmatic cleft and spine, × 450 ; *c*, adult ♀, anterior extremity, × 9 ; *d*, do., antenna, × 130 ; *e*, anterior leg, × 220 ; *f*, dermal cells of dorsum, × 220 ; *g*, dermal cells of venter, × 220 ; *h*, stigmatic spines, × 450 ; *i*, tubular pores from stigmatic area, × 220.

presented by T. Steel, Sydney." The authority for the determination is not stated and, as the structural characters do not agree either with Maskell's original diagnosis or with Morrison's more recent description, I have thought it advisable to describe this insect as a new species.

Asterolecanium charmoyi, sp.n. (fig. 4).

Sac of adult female closely resembling, in size and colour, that of *A. lanceolatum*, Green ; but relatively broader. Average length 1·25, breadth 0·5 mm. Adult female insect (fig. 4, *a*) narrow, elongate, tapering posteriorly. Margin with a close series of sharply defined, small, paired pores, interrupted at the caudal extremity only. Dorsum with a few larger submarginal paired pores, of which (in the type example) there are four on the cephalic area and four on the abdominal area, disposed asymmetrically. Mouth-parts large and conspicuous. Spiracles connected with the margin by a series of minute simple pores which are continued along the margin for a short distance, in both directions. Posterior extremity (fig. 4, *c*) with a pair of well-defined inner lobules, each surmounted by a slender spine. Caudal setae moderately stout. Anal ring broad, rather strongly chitinized ; with six setae. Exterior rim of anal tube with a sharply defined, narrow, curved, transverse chitinous plate. Length, 0·75 mm.

On foliage of *Bambusa* sp. ; principally upon the lower surface. Mauritius. Coll. d'Emmerez de Charmoy.

Distinguishable from *pseudomiliaris*, Green, by the closer series and greater number of the marginal paired pores, and by the greatly reduced number and relatively smaller size of the supplementary paired pores on the dorsum.

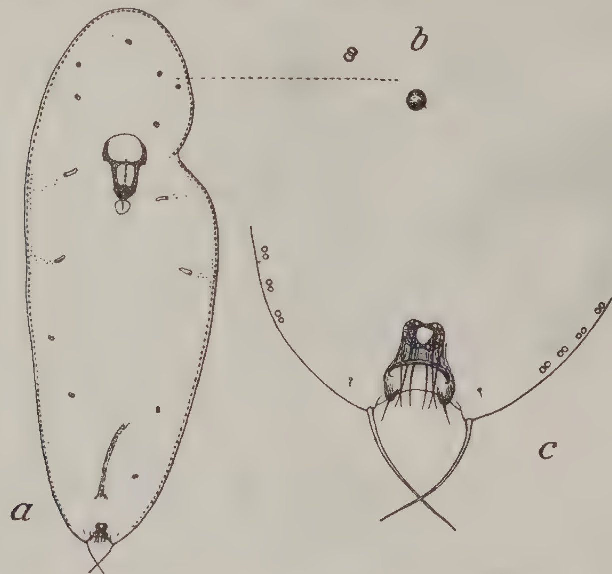


Fig. 4. *Asterolecanium charmoyi*, Green, sp.n.: *a*, adult insect, × 130; *b*, antenna and one of the frontal paired pores, × 450; *c*, posterior extremity, × 450.

Ripersia exul, sp.n. (fig. 5).

Form broadly ovate. Length 3 to 3·5, breadth 2 to 2·25 mm. Caudal lobes not produced; posterior extremity evenly rounded. Antennae (fig. 5, *a*) relatively stout, 7-jointed: 7th longest, as long as 4, 5 and 6 together; 2nd slightly longer than broad; 3 to 6 short, of approximately equal length. Labium (fig. 5, *c*) 2-jointed, broad and short, bluntly pointed, the base as wide as or wider than the total length, the basal shorter than the apical joint. Rostral loop short, extending but slightly below the tip of the labium. Limbs small, but robust (fig. 5, *f*); all of approximately equal size. Tarsi approximately two-thirds length of tibiae. Hind coxae without conspicuous translucent pores. Claw with a minute (scarcely distinguishable) denticle (fig. 5, *e*). Ungual digitules slender, slightly dilated at distal extremity, reaching tip of claw. Tarsal digitules slender, simple, extending to about half the length of the claw. With cerarii on the last two segments only; each indicated only by 2 very minute conical spines, without grouped pores; the caudal cerarius with one long and stout seta, one of about half the length, and two much smaller. No auxiliary setae on the second cerarius. Setae of anal ring long and stout, but slightly shorter than the caudal setae. Body setae small and sparse, except on frons, where they are larger and more numerous. Body pores of the obscurely triangular type very minute, scattered over the whole surface, more numerous on the posterior abdominal segments. Discoid pores sparsely distributed on the posterior abdominal segments only.

Type material from nests of ants, on a minute uninhabited islet (Chapel Dom Hue), 20 yards square, off the west coast of Guernsey. The same species was taken on a

similar islet (Rat Island), off the coast of Herm. The female insects construct conspicuous, white, globular or ovate ovisacs, some of which measure 5 mm. in diameter. Coll. J. R. le B. Tomlin. 24. vii. 1923.

The species differs from *tomlini*, Newst. (described originally from the Island of Guernsey) in the following characters :—Antennae more robust : 3rd joint shorter than 2nd (*cf.* figs. *a* and *b*). Labium broader and shorter (*cf.* figs. *c* and *d*). Limbs smaller but relatively more robust (*cf.* figs. *f* and *g*).

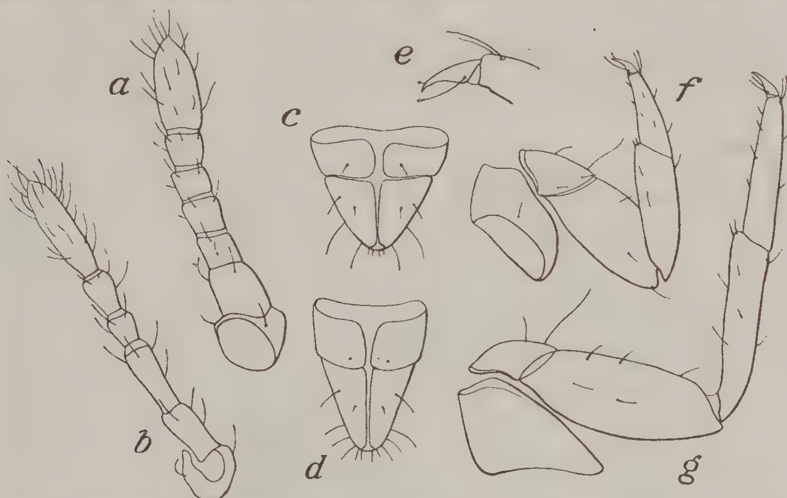


Fig. 5. *Ripersia exul*, Green, sp. n. : *a*, antenna, 220 ; *c*, labium, × 220 ; *e*, foot, × 450 ; *f*, third limb, × 220. *Ripersia tomlini*, Newst. : *b*, antenna, × 220 ; *d*, labium, × 220 ; *g*, third limb, × 220.

In drawing up these comparisons I have been unable to examine the type of *tomlini*, but have relied upon material, collected by Mr. Tomlin in Guernsey, which agrees with the characters of the species given by Newstead in his original description (Ent. Mo. Mag. s.s. iii, June 1892, p. 146). *Ripersia tomlini* is more particularly distinguished by the unusually elongate 3rd antennal joint.

Ripersia longisetosa, sp.n. (fig. 6).

Adult female (fig. 6, *a*) broadly ovate. Length 1·3, breadth 0·9 mm. Caudal lobes rounded, very slightly prominent. Antennae (fig. 6, *b*) 6-jointed ; 6th longest and widest, ovate ; 2 and 3 cylindrical ; 4 and 5 broader distally. Labium elongate, bluntly pointed ; distinctly 2-jointed, the distal joint more than twice the length of the basal joint. Spiracles of approximately equal size. Limbs well developed (fig. 6, *a*), relatively large ; all of approximately equal size. Tarsi approximately two-thirds the length of the tibiae (fig. 6, *c*). Hind coxae without conspicuous translucent pores. Claw (fig. 6, *d*) with an extremely minute (scarcely perceptible) denticle near the distal extremity. Ungual digitules represented by a pair of minute bristles. Tarsal digitules simple, short, less than half the length of the claw. Cerarii (fig. 6, *e*) in seventeen pairs, each bearing two long stout setae in place of spines ; one (sometimes two) smaller seta midway between each cerarius, except on the anterior three or four segments ; the caudal cerarius (fig. 6, *f*) with 3 or 4 long auxiliary setae. Anal ring with 6 setae, slightly shorter than the caudal setae. Body pores of the small, obscurely triangular type, numerous, distributed over the whole body,

more crowded on cerarial tracts. Discoid pores few and inconspicuous. Body setae small and sparse.

In nests of an ant (*Plagiolepis* sp.), S. Africa (Table Mountain, 1,000 ft.). Coll. P. A. Buxton. Received through Mr. H. Donisthorpe.

Fig. 6. *Ripersia longisetosa*, Green, sp. n.: *a*, adult ♀, × 50; *b*, antenna, × 220; *c*, third leg, × 220; *d*, claw, × 450; *e*, cerarii from mesothoracic area, × 450; *f*, caudal lobe and setae, × 450.

Pseudococcus cimensis, nom. nov.

Pseudococcus artemisiae Green, Bull. Ent. Research, xiv, pt. 1, July 1923, p. 92.

My attention has been drawn, by Prof. Cockerell, to the fact that this name is preoccupied by *Pseudococcus artemisiae* of Essig (Essig, Pomona Journ. Ent., i, 2, p. 38, 1909). Essig's species has since been referred to *Erium lichtensioides*; but having once been employed, the use of the name for any other species is prohibited. I therefore propose the new name *cimensis* for this insect from the I. de Cima, Madeira.

AN IMPROVED FORM OF APPARATUS FOR "LOW POWER" INSECT PHOTOMICROGRAPHY.

By John F. Marshall, M.A., F.E.S.

(Plate I.)

The apparatus here illustrated (Plate i) has been devised by the writer for photographing mosquitoes by the method generally known as "low power photomicrography," in which a long extension camera fitted with a short focus photographic lens is employed.

Experiments with various forms of apparatus previously used for this purpose showed that (as far as the particular work in question was concerned) none of them was at all likely to give satisfactory results. For one thing, it was found that the customary methods of illuminating the object left much to be desired; it being difficult (not to say impossible) to show the details of body markings and of wing venation with equal clearness in the same picture.

In low power photomicrography the insect is generally "mounted" on a plane surface of cardboard, celluloid, glass, etc., which we may conveniently designate as the "stage." In the methods hitherto employed, the planes of the stage and of the focussing screen of the camera are mutually perpendicular to the camera axis, the forms of apparatus being divisible into two groups, according as the camera is fixed in a horizontal or a vertical position.

Neither of these arrangements is completely satisfactory. When the camera is horizontal, the resulting vertical position of the focussing screen is much to be preferred (both as regards the comfort of the operator and for various other reasons); but, owing to the vertical position also assumed by the stage, the satisfactory "posing" of an insect such as a mosquito is difficult to carry out.

In the apparatus under consideration the combination of a *vertical* focussing screen with a *horizontal* stage is effected by the use of a right-angled (internally reflecting) prism, placed in line with the camera lens and vertically above the stage.

The lighting arrangements also differ from previous practice, the mosquito being supported on a transparent stage and illuminated simultaneously from above and below, two separate sources of light being employed. By correctly proportioning the intensities of the respective illuminations, the mosquito appears upon a "shadowless" background with the body markings and the wing venation both clearly defined.

The reflecting prism is fitted in the lower end of the tube A^1 (Plate i), the portion of this tube in line with the camera lens being cut away. The tube A^1 is slidable within the tube A^2, which is supported rigidly by the bracket B. Vertical adjustment of the prism is effected by means of the screw C.

Vertically below the prism tube A^1 is the stage D, which consists of a centrally bored glass disc, upon which the mosquito is mounted in the following manner. The head of a No. 20 D. F. Tayler pin (which is about 1/100 inch diameter) having been cut off, the point is inserted between the fore legs of the mosquito, care being taken that the pin does not protrude through the upper surface of the thorax. The shaft of the pin is then gently lowered through the central hole in the disc until the legs of the mosquito rest on the surface of the glass; the mosquito may then be "posed" very easily. The discs actually used (which have been specially made by Messrs. Adam Hilger, Ltd.) have a diameter of $1\frac{7}{16}$ inch, the diameter of the central hole being 1/64 inch. The supporting pin, fitting loosely in the hole, hangs vertically and is therefore hidden completely from the camera by the body of the mosquito.

The mounted mosquito can be distinguished in the centre of the disc D in each of the accompanying illustrations.

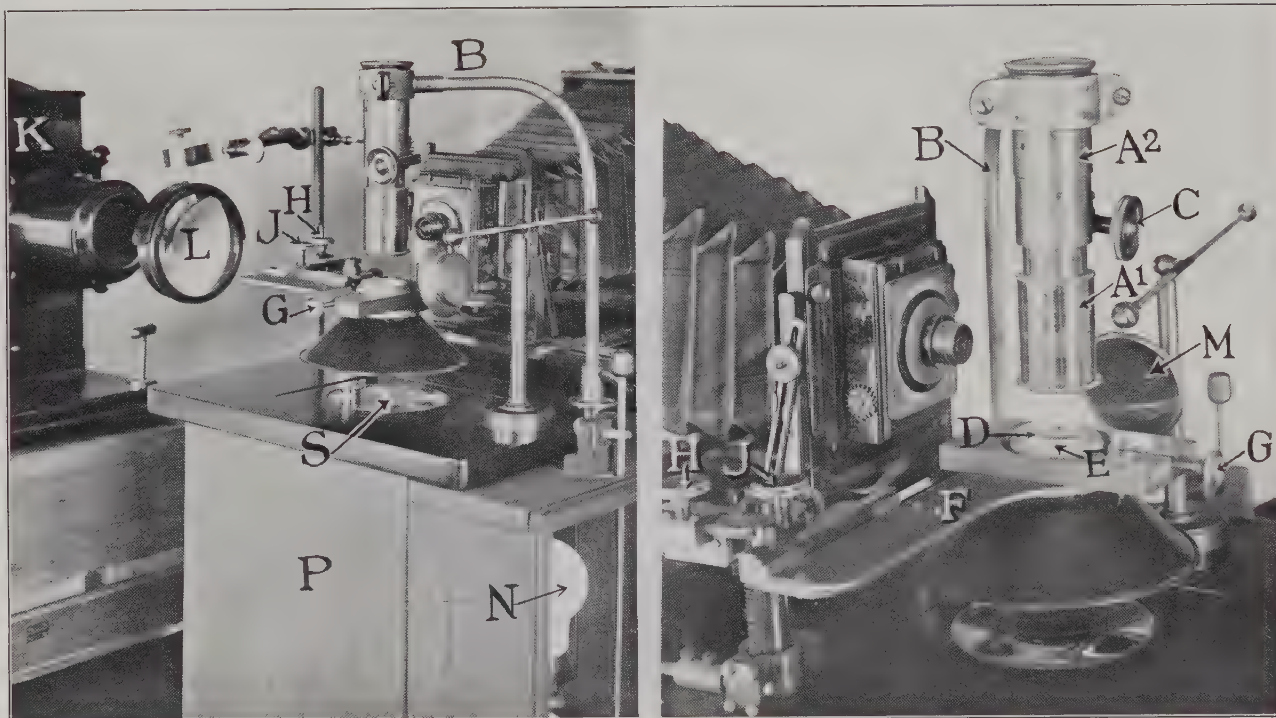
The disc D is carried in a flanged ring E, which may be completely rotated in the plane of the platform F by means of the screw G. The platform F is movable towards, or across, the front of the camera by the screws H and J, respectively, each of these screws being provided with vernier scales. The platform F may also be moved vertically by means of the rack-and-pinion shown in the lower left-hand corner of the right-hand figure (Plate i).

As previously stated, the mosquito is illuminated simultaneously from above and below. The lighting from above is derived from the projection lantern K (with the objective, but not the condenser, removed), the plano-convex lens L, and the adjustable concave mirror M.

The lighting from below is effected by the opal electric globe N, the rays from which are reflected upwards by a plane mirror fixed at an angle of 45° within the box P. A plano-convex lens S is interposed horizontally between this mirror and the glass disc D.

In the right-hand figure (Plate i) the projection lantern K and the lens L have been removed.

A half-plate camera is employed, extensible to 28 inches and fitted with a "Holostigmat" lens of 3 inch focus, made by Messrs. Watson & Sons. The sources of light for the upper and lower illumination are of 800 c.p. and 120 c.p. respectively. With a camera extension of 26 inches a magnification of about 7 is obtained. With this magnification the surface of a half plate is nicely "filled" by the picture of a mosquito of average size.



An improved apparatus for photographing insect under low magnifications.

THE ACTION OF SOME ORGANIC COMPOUNDS WHEN USED AS STOMACH POISONS FOR CATERPILLARS.

By E. Hargreaves, F.E.S.

This work was commenced in 1919 and continued in 1920 and 1923. The writer's thanks are due to Prof. H. Maxwell Lefroy, who provided facilities for the carrying out of the work at Westbrook House, Heston, and showed great interest in its progress. Publication of the results has been delayed in the hope that further experiment could be made in the near future.

It is known that some organic compounds, *e.g.*, naphthalene, are of use as stomach poisons for caterpillars, but little work has been done except with mineral compounds, of which Lefroy and Finlow tested a large number. The effect of some organic substances on house-flies is described in a paper by Jackson and Lefroy, who found the dinitrocresylates and salicylates to be first-class poisons.

The present tests were made in an endeavour to find some efficient substitutes for the arsenates which would be innocuous or much less toxic to man and other animals, and to indicate the directions for further research. Any available organic compound either metallic or non-metallic was tried, in addition to some inorganic substances. One per cent. mixtures were first used, and where a fairly good killing effect was obtained, other strengths were tried in order to give some indication of the optimum. It appears to be advisable in any future tests that at least three different concentrations be used in every case.

The caterpillars used were those of *Pieris rapae*, L., and *Spilosoma lubricipeda*, Esp., with leaves of cabbage and lupin respectively for food, the *Spilosoma* being indicated in the tables by the letters BE. Larvae about half-grown were generally used, but towards the end of the season sufficient of these were not available, and pupation interfered to some extent with the tests. The larvae that died as a result of wilt disease, parasites or cannibalism, as well as any which pupated, are not included in the figures except those of the controls.

Compounds were applied as emulsions where possible, made with a standard liquid soap composed of olein 37·5 cc., 90 per cent. alcohol 19·0 cc., ammonia (0·880) 9·0 cc. Some of them, mainly acids, would not emulsify and for these a one per cent. starch paste was found to be a satisfactory carrier.

Technique.

The compound (0·25 gram) was finely ground in a mortar, well mixed with (*a*) 1·0 cc. of the liquid soap, 24 cc. of distilled water being gradually added so as to form a good one per cent. emulsion, or (*b*) 25 cc. of the starch paste. Each was well agitated before use.

The leaves were first immersed in 90 per cent. alcohol to break the surface film, and allowed to become nearly dry. The mixture was then applied by means of a small brush, care being taken to cover the whole of the upper and lower leaf surfaces uniformly. This was found to be the only satisfactory method, as with dipping or spraying the distribution of the mixtures was unreliable. The treated leaves were allowed to dry, then placed in a covered jar with the caterpillars, generally five. Although this number is not large, it was thought to be sufficient to indicate the relative values of the compounds tested and the lines of further work. Daily observations were made, when the leaves were replaced by freshly treated material and the amount eaten roughly estimated.

Toxic effect is shown in terms of caterpillars killed, and days: *e.g.*, with one per cent. nicotine emulsion one larva died on each of the second, third, fifth and seventh days, a total of four dead in seven days. and the record is 1/2, 2/3, 3/5, 4/7, thus showing the progress of the action. The last figure gives the duration of the experiment in each case. For the purposes of this paper seven days was ordinarily considered ample time to allow for the compound to show its toxic properties.

There was marked aversion to the treated food in many cases, and it is suggested that this property could be made of more practical use, *i.e.*, a compound may be used purely as a deterrent, or the deterrent and toxic effects together may be as efficient, for crop protection, as a first class stomach poison. It is also probable that some such compounds could be used without danger to man and domestic animals. It is of course necessary that they be stable, insoluble or nearly so in water, and have no deleterious effect upon the plant.

Table of Results.

N.B.—All compounds were applied as emulsions except those marked "S," which were starch paste suspensions. The concentrations used were of 1 per cent. unless otherwise stated. *Pieris* larvae were used except where *Spilosoma* are indicated. BE = *Spilosoma* larvae, D = deterrent, MD = markedly deterrent, N = negative, P = parasitised, W = died from wilt disease, V = variable feeding.

Compound.	Per cent. strength used.	Emulsion or suspension.	No. of larvae used.	No. dead in days.	Feeding and remarks.
(A) *Non-metallic.*					
Phenylacetic acid		S		0/7	N
Alizarin				0/7	N
Diphenylamine				1/4, 1/7	V
Dinitrodiphenylamine				1/4, 2/11	
Metaphenylenediamine				0/7	N
Metatoluylenediamine				2/7	N
Dianesidine				1/2, 2/4, 3/5, 3/7	MD
,,	2	S		2/3, 3/7	DV
Sulphanilic acid		S		0/7	N
Orthochloraniline				1/8, 1/12	
Metanitraniline				1/4, 1/11	N
Anthracene				0/7	N
Dichloranthracene (add.)				0/7	V
Dichloranthracene (subs.)				0/7	V
Benzamide				2/6, 2/7	N
Paradichlorobenzene				1/3, 1/7	N. Thick emulsion
,,	0·5			0/7	N
Chlornitrobenzene				1/2, 1/7	N
Metachlornitrobenzene				3/12	
2 : 4 dinitro-1-chlorbenzene				1/4, 2/5, 3/6, 3/7	V
,,	2			1/3, 3/6, 3/7	MD
,,	0·5			0/7	V
Dinitrobenzene				1/3, 2/4, 2/7	V
Benzidine				0/7	N
Benzoic acid		S		0/7	N
Benzophenone		S		1/6, 1/7	N
Chlororthocresol				1/1, 2/4, 3/5, 3/7	V. Thick emulsion
,,	2			1/3, 4/5, 4/8	V
Fluorehone				1/4, 1/11	
Fluorene				1/7, 2/9, 3/11	
Paraformaldehyde		S		0/7	N
Phenylhydrazine hydrochloride		S		1/1, 2/4, 2/7	MD
,,	2	S		1/2, 2/5, 2/8	MD
Diphenylmethane				0/12	

Compound.	Per cent. strength used.	Emulsion or suspension.	No. of larvae used.	No. dead in days.	Feeding and remarks.
Phenyl mustard oil				1/5, 1/12	
Naphthalene				1/2, 1/7	D. V
Naphthalic acid		S		1/4, 1/11	
Naphthalene sulphonic acid				0/7	N
Trichlornaphthalene				2/4, 3/6, 3/7	MD
,,	2			1/1, 3/2, 3/8	D
,,	0·5			0/7	
Alphanitronaphthalene				1/2, 2/3, 3/6, 3/7	D
,,	2			2/3, 4/5, 4/8	V
,,	0·5			0/7	
Dinitronaphthalene				1/5, 1/7	V
Alpha naphthol				1/4, 2/5, 3/7	V
,, ,,	2			2/3, 5/5	D
,, ,,	0·5			0/7	
Beta naphthol				1/3, 2/4, 3/7	MD
,, ,,	2			1/3, 3/5, 3/8	D
,, ,,	0·5			2/3, 2/7	
Alpha naphthylamine				1/2, 2/4, 2/7	D
,, ,,	0·5			0/7	
Beta naphthylamine				1/1, 2/2, 3/3, 3/7	D, V
,, ,,	2			1/3, 3/5, 3/8	D, V
,, ,,	0·5			0/7	V
Dinaphthylamine (beta beta)				1/3, 2/4, 2/7	N
Nicotinic acids		S		1/4, 2/7, 2/11	
Phenanthrene				1/5, 1/7	D, V
Monochlorphenanthrene (add.)				2/5, 3/6, 3/7	MD
,,	2			3/5, 3/8	V
Orthonitrophenol				1/2, 1/7	D, V
Paranitrophenol				2/7	MD
Dinitrophenol				2/1, 3/2, 3/7	MD
,,	2	S		2/2, 3/3, 3/8	MD
Diphenyl				1/4, 1/11	MD
Picric acid				1/6, 1/7	D
Pentachlorpyridine				1/11	
Quinine sulphate		S		1/5, 2/6, 2/7	MD
Quinoline-8-sulphonic acid		S		0/11	
Ana amidoquinoline				0/9	
Ortho amidoquinoline				0/11	
Aceto ana amidoquinoline				1/6, 1/11	
-8-chlorquinoline				0/12	
-2-hydroxyquinoline				1/7, 3/12	
-8- ,,				0/11	
-8-hydroxyisoquinoline				1/5, 1/12	
-5-nitroisoquinoline				2/4, 2/11	
-6-methylquinoline				1/5, 2/7, 2/12	
Ana nitroquinoline				0/9	
Ortho nitroquinoline				1/1, 2/6, 2/11	
Ana nitroquinoline nitrate		S		1/7, 1/11	
Resorcinol				0/7	N
Salicylic acid		S		0/7	D
Tolidine		S		0/7	
Chlororthotoluene				1/5, 1/12	
Dinitrotoluene				1/4, 1/7	N
Paratoluenesulphonchloride				1/6, 1/7	N
Paratoluidine				1/4, 1/7	V
Diphenyl thio urea				0/12	
Dialphanaphthyl thio urea				0/12	
Dibeta ,,				0/12	
Di-5-quinoline thio urea				0/12	
1 : 4 : 2 xylenol				1/9, 2/11	
1 : 3 : 4 ,,				1/7, 1/12	
Para xylidine hydrochloride		S		0/11	

Compound.	Per cent. strength used.	Emulsion or suspension.	No. of larvae used.	No. dead in days.	Feeding and remarks.
(B) *Metallic.*					
Copper sulphanilic acid		S		2/4, 2/7	D
Lead ,, ,, ...		S		0/7	
Lead orthocresol sulphonic acid		S		0/7	
,, paracresol ,, ,, ..		S		1/7	
Mercury ortho cresol sulphonic acid ..		S		1/7	
,, meta ,, ,, ,, ..		S		0/7	MD
,, para ,, ,, ,, ..		S		1/6, 1/7	V
Zinc ortho ,, ,, ,, ..		S		0/7	D
,, meta ,, ,, ,, ..		S		0/7	
,, para ,, ,, ,, ..		S		0/7	V
Barium orthocresol monosulphonic acid ..		S		1/5, 1/7	
Sodium ,, ,, ,, ..				0/7	N
Barium salt of chlororthocresol sulphonic acid..		S		0/11	
Ammonium dinitro ortho cresylate ..				1/2, 2/3, 2/4	MD incomplete
,, ,, ,, ,, ..	2			2/1, 3/3, 4/4, 5/6	MD
,, ,, ,, ,, ..	0·5			1/1, 2/2, 3/3, 5/5	MD
,, ,, para ,, ..				1/3, 3/4, 4/5, 5/6	D, V.
,, ,, ,, ,, ..	2			1/2, 2/3, 3/5, 3/8	D, V.
,, ,, ,, ,, ..	0·5			1/3, 2/4	MD incomplete
Cobalt salt with formula Co (CNS) CHN				0/11	
,, ,, ,, ,, ,, ,, ,,		S		0/9	
Copper ,, ,, ,, Cu ,, ,,				0/11	poor emulsion
,, ,, ,, ,, ,, ,, ,,		S		0/9	
Nickel ,, ,, ,, Ni ,, ,,				0/11	
,, ,, ,, ,, ,, ,, ,,		S		0/9	
Zinc ,, ,, ,, Zn ,, ,,				0/11	
,, ,, ,, ,, ,, ,, ,,		S		0/11	
Barium ,, of naphthionic acid				3/8, 3/9	
Copper ,, of ,, ,,		S		0/11	
Lead ,, of ,, ,,		S		1/6, 1/7	
Sodium ,, of ,, ,,				0/7	
Ammonium naphthalene beta sulphonic acid				0/7	V
Sodium naphthalene beta sulphonic acid..				0/7	N
Barium methyl naphthalene sulphonic acid				0/7	V
Sodium methyl naphthalene sulphonic acid				0/7	N
Calcium naphthalene sulphonate		S		0/7	N
Lead ,, ,,				1/6, 1/7	
Sodium ,, ,,				2/6, 2/8	N
Barium betanaphthylamine sulphonic acid 1st series		S		0/11	
Barium betanaphthylamine sulphonic acid 2nd series		S		1/4, 3/6, 3/11	MD
Copper betanaphthylamine sulphonic acid 1st series		S		0/11	
Copper betanaphthylamine sulphonic acid 2nd series		S		0/11	
Lead betanaphthylamine sulphonic acid 1st series		S		0/11	
Lead betanaphthylamine sulphonic acid 2nd series		S		0/11	
Lead phenol sulphonic acid		S		0/7	
Zinc ,, ,, ,, ...		S		0/7	

Compound.	Per cent. strength used.	Emulsion or suspension.	No. of larvae used.	No. dead in days.	Feeding and remarks.
Barium dinitrophenol sulphonic acid ..		S		0/7	
Potassium ,, ,, ,, ..		S		0/7	
Sodium diphenyl sulphonate		S		0/11	
Barium salt of quinoline-8-sulphonic acid		S		1/11	
,, ,, ,, 5 ,, ,,		S		0/9	
Calcium ,, ,, 5 ,, ,,				0/11	
Copper ,, ,, 8 ,, ,,		S		0/11	
Lead ,, ,, 8 ,, ,,		S		0/11	
Sodium ,, ,, 8 ,, ,,				0/11	
,, ,, ,, 5 ,, ,,		S		0/11	
Calcium ,, -6-isoquinoline ,, ,,		S		0/11	
Sodium ,, 6 ,, ,, ,,		S		0/11	
Potassium salicylate		S		0/7	MD
,, ,, ...	0·5	S		1/7	
,, ethyl xanthate				0/6	
(C) *Inorganic.*					
Antimony trioxide	0·5		6	0/11	BE, N
,, ,, ...	0·25		10	1/4, 2/5, 2/9	BE, N
Barium fluoride		S	9	2/3, 3/6, 5/7, 9/9	BE, N
,, ,, ...	0·5	S	9	3/5, 6/9	BE, N
Boric acid		S		1/5, 1/7	D
,, ,, ...	0·5	S		0/7	
Calcium arsenate		S	9	1/2, 4/4, 7/5, 9/6	BE, MD
,, ,, ...	0·5	S	9	1/2, 3/4, 4/5, 7/6, 9/7	BE, N
Calcium fluoride (pptd.)		S		3/4, 5/5	D
,, ,, ...		S	6	1/11	BE, N
,, ,, ...	2	S		2/2, 5/3	N
,, ,, ...	0·5	S	8	0/11	BE, N
Calcium fluoride (fluorspar)		S	4	1/9	BE, N
,, ,, ...	0·5	S	9	1/6, 3/10 3/11	BE, N
Calcium fluoride (colloidal suspension with gum arabic)			9	1/2, 2/10	BE, N
Sodium fluoride		S		2/4, 4/5, 4/7	MD
,, ,, ...	2	S		3/3, 4/5, 4/8	D
,, ,, ...	0·5	S		1/7	D
Sodium fluosilicate		S		1/8, 1/9	BE, D
,, ,, ...	0·5	S	8	1/2, 2/4, 3/9, 3/10	BE, N
(D) *Controls.*					
Potassium dinitro-orthocresylate (Antinonnin)				1/1, 2/2, 3/3, 4/6, 4/7	MD
Potassium dinitro-orthocresylate ..	2			1/2, 2/3, 4/5, 4/8	MD
Potassium dinitro-orthocresylate ..	0·5			1/1, 2/3, 4/4, 5/6	
Nicotine(95%-98%)				1/2, 2/3, 3/5, 4/7	V
,, ...		S	9	2/9	BE, N
,, ...	2			1/2, 2/3, 3/5, 3/8	DV
,, ...	0·5			0/7	
,, ...	0·5	S	10	0/11	BE, N
,, ...	0·25	S	8	0/11	BE, N
Lead arsenate		S		1/2, 2/4, 4/6, 4/7	MD
,, ,, ...	2	S		2/3, 3/5, 3/8,	MD
,, ,, ...	0·5	S		1/3, 1/7	MD

Compound.	Per cent. strength used.	Emulsion or suspension.	No. of larvae used.	No. dead in days.	Feeding and remarks.
Starch paste				4/13	WN
„ „			10	1/13, 2/14	WN
Liquid soap	4			1/5, 2/6, 3/9, 3/16	2P 1 eaten
„ „	4			1/9, 3/14, 3/19	N, 1P, 2W
„ „	3·3		9	1/5, 2/7, 3/10, 4/11	BE, N (1P 3W)

The following points are of particular interest :—

(1) The very toxic character of the dinitrocresylates, all the strengths used being deterrent, and the ammonium ortho compound proving the most toxic, as was found by Jackson and Lefroy in their study of fly poisons.

(2) Apart from the above, all the metallic organic compounds tested are relatively innocuous, with the exception of two barium salts, both related to naphthalene.

(3) The general toxic action of the naphthalene derivatives, particularly the naphthols, naphthylamine, and chlor- and nitro-naphthalenes, which is much greater than that of naphthalene itself.

(4) There appear to be possibilities with chlororthocresol, monochlorphenanthrene, dinitrophenol and dianesidine, or with some compounds related to them.

(5) The high toxicity of barium and calcium fluorides and the possibility of the use of fluor-spar as an insecticide.

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AN IMPROVED LIGHT TRAP FOR INSECTS.

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In Bulletin No. 28 of the Technical and Scientific Service of the Ministry of Agriculture of Egypt I described a new type of light trap for collecting insects which had the advantages that the insects were rapidly killed in good condition for identification, that the light was visible in all directions, and that it could be used with either electricity or acetylene by an untrained worker.

The trap, as there described, had been in successful use for several months, and on some occasions captures were made during a single night of several thousand

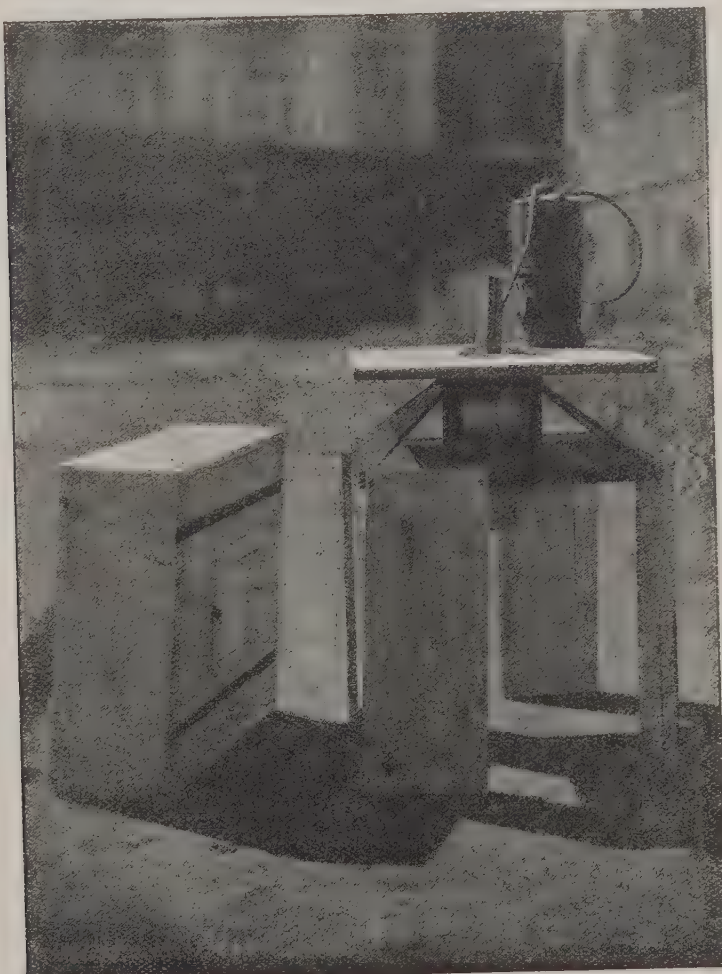

Fig. 1. General view of light trap.

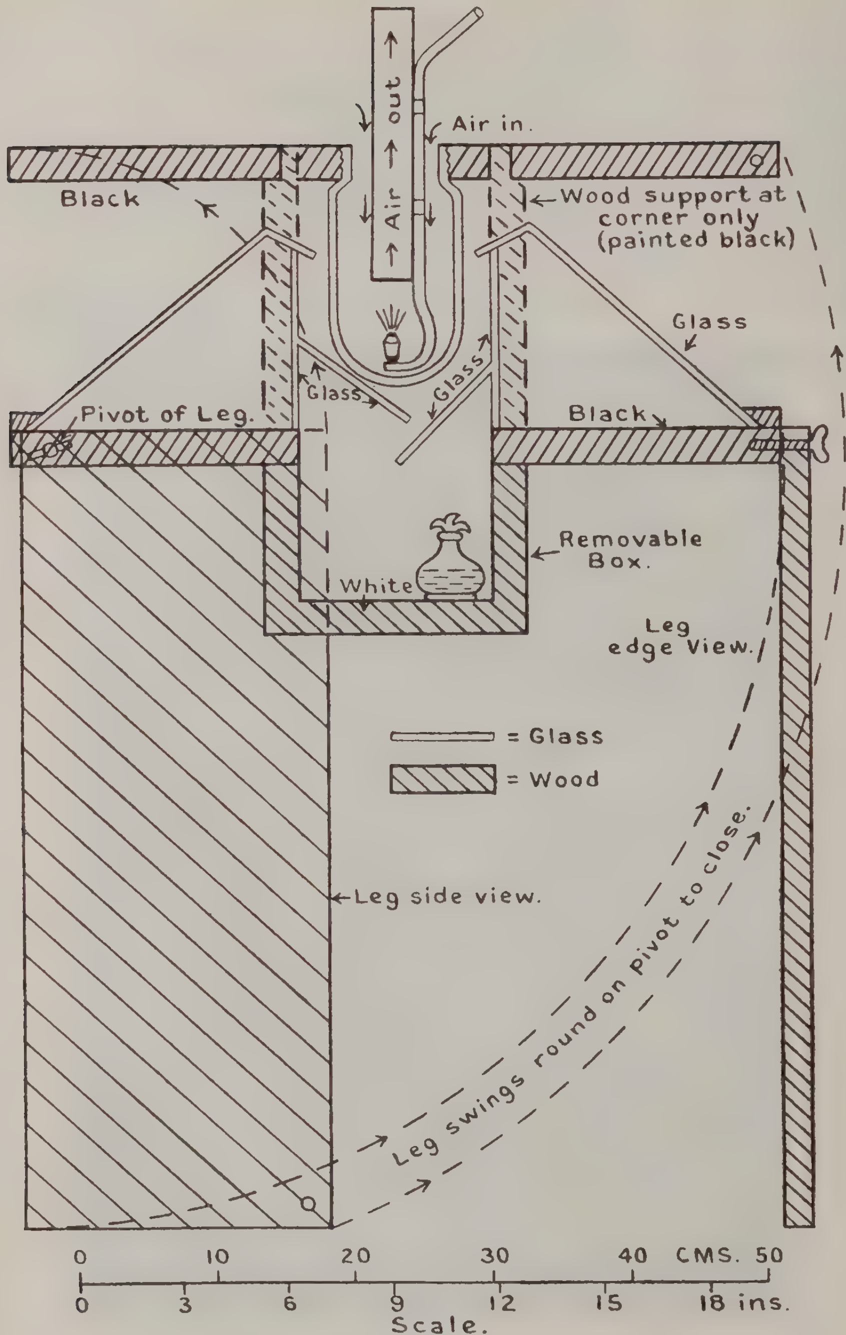

Fig. 2. Details of construction of light trap.

insects. With more experience, however, it was found that the trap could be improved in several ways, and particular effort was made to make it smaller, simpler, and less liable to break. As a result, the trap described below has been evolved. It differs from the first model in the absence of mirrors and in the arrangement of the legs, which now completely enclose the trap when it is not in use.

It must be emphasised that this trap is for the purpose of obtaining insects in good condition for identification and not merely for the wholesale destruction of pests. For the latter purpose a much simpler arrangement can be used.

I am indebted to Mr. T. W. Kirkpatrick for helpful criticism and suggestions.

The new trap (see figs. 1 and 2) consists of a square box with open sides supported on legs. It is about two feet square and three feet high when the legs are unfolded ; when folded it is a box about two feet square by nine inches deep.

In the middle of the top of the trap is an inverted globe, closed beneath, in which is the source of light (acetylene or electricity). This globe is in a small glass-sided box (the central chamber), which reaches from the floor of the trap to about one and a half inches from the roof, and the insects are led to the opening by sloping glasses from the outer bottom edge of the trap. From this opening the insects flutter downwards towards the light and come into the glass chamber which surrounds the globe. Sooner or later they get between the two sloping glasses beneath the light into the lower chamber, which consists chiefly of a removable box, and here they are overcome by the fumes evaporating from the container.

The legs, the bottom and top of the trap, the removable box, and four supports supporting the top of the box (one at each corner of the centre chamber) are of wood. The four entrance slopes, the sides of the central chamber, the two sloping pieces beneath the globe and four small sloping pieces at the top of the central chamber are of glass. These glasses are edged with a narrow tin strip folded over on each edge where they meet another glass, and these strips are soldered together to form the main frame of the trap.

Every part of the wood work and metal work of the trap on which light falls is painted black, with the exception of the inside of the removable box which is white. This is to discourage the insects from settling in any place except within the poison chamber.

The flat legs are pivoted at one corner to the edge of the bottom of the trap and when rotated upwards each leg completely closes one side of the trap. The opposite corner of the leg to the pivot is then secured by a wing bolt to the top of the trap. The whole forms a compact portable box as shown to the left in fig. 1.

To use the trap the top wing bolt is removed, the leg is swung downwards, and the wing bolt is replaced in a second hole in the corner of the leg next to the pivot and screwed into a place made to receive it in the bottom of the trap. The result is a firm flat leg. The small wooden box beneath the trap is removable by a swing hook and eye ; when travelling it is replaced by a flat piece of wood, and the opening in the top from the globe is also closed by a piece of wood, pivoted at one corner.

The glass globe screws into the wooden top, which is itself freely removable from the four supports and, except when closed, rests in position by its own weight. When used for electricity the bulb is lowered into the central globe. When used for acetylene a burner with a metal chimney attached has to be employed, as shown, to allow for the free circulation of air.

The killing agent usually used is carbon tetrachloride, which has the advantage of giving a moderately poisonous, heavy, non-inflammable vapour. Carbon bisulphide is more poisonous, but is inflammable and explosive and is not recommended except for use with electric light. With this, however, it has been used with great success. The liquid is placed in a small spirit-lamp container and evaporates slowly from the wick during the night. Good results are obtained with carbon tetrachloride by arranging the wick so that about two ounces are evaporated during the night. If

there is much wind more will be required. It is probable that potassium cyanide could be adapted, but owing to HCN gas being lighter than air it would tend to be lost upwards more rapidly.

It has been found that good results are only obtained with a deep box. At present the one in use is 10 cm. deep ; when this was reduced to 5 cm. the majority of the insects were not killed sufficiently rapidly, and were as a result in very poor condition.

The principal dimensions of the trap are given below and also can be seen from the scale drawing. The determining factor is the size of the glass globe obtainable to contain the light, and also the slope of the main glasses, which must not be too steep. If the trap were being used for electricity only, this globe could be done away with altogether and the electric bulb hung in the central chamber. In this case the trap could be made a few inches smaller in each direction, as the central chamber could be made smaller and lower.

It may be stated that a light trap of this type travelled with a survey party for nearly three months on a camel, over the Egyptian desert, without any breakage, and others have been sent long journeys by rail and by motor car.

The weight of the complete trap with the woodwork 1 inch thick is 19 kilos. (44 lb.). For work in which much travelling is not required the woodwork could be thinner, with a corresponding reduction of weight.

The trap costs to construct in Egypt just over one hundred and fifty piastres (thirty-one shillings or eight dollars), including glass, metal work, woodwork and all painting, but not including the generator and burner for acetylene. The generator should contain enough carbide to keep the trap alight for twelve hours and costs in Egypt about one pound. The burner costs about 40 piastres (eight shillings—two dollars).

The principal dimensions of the trap are as follows :—

	Cm.	Inches.
Width (square)	58	$22\frac{3}{4}$
Height open	32	13
Height closed	22	$8\frac{3}{4}$
Height of legs	58	$22\frac{3}{4}$
Width of legs	22	$8\frac{3}{4}$
Width of inner chamber	14	$5\frac{1}{2}$
Diameter of globe	10	4
Length of globe	15	6
Space between top of glass slope and roof	$3\frac{1}{2}$	$1\frac{1}{2}$
Sloping glass, long side	52	$20\frac{1}{2}$
Sloping glass, short side	18	7
Sloping glass, sloping side	28	11
Chimney, depth	5	2
Chimney, breadth	$3\frac{1}{2}$	$1\frac{1}{2}$
Chimney, length	25	$9\frac{3}{4}$
Box, inside width	14	$5\frac{1}{2}$
Box, inside depth	10	4

[*Note.*—Since writing the foregoing excellent results have been obtained by using potassium cyanide as a killing agent instead of carbon tetrachloride. The method employed is to take a lump of cyanide weighing about 1 oz. (in actual practice a specially moulded egg-shaped lump of exactly one ounce as supplied for fumigation) and enclose it in a thin layer of moist plaster of Paris. This rapidly dries, forming a protected lump which can be easily and safely handled. This lump is kept in a bottle when not in use and is placed in the box of the trap when in use. The fumes of HCN come off all round and a strong poison atmosphere is maintained. The method is cheaper and more convenient than the use of carbon tetrachloride, and appears to give as good, if not better, results.

ON SOME EGYPTIAN CERATOPOGONINAE.

By J. W. S. MACFIE.

The small collection of CERATOPOGONINAE described in this note was made by me last December (1923) during a short voyage on the Nile from Cairo to Assuan and back. The steamer on which the voyage was made anchored at night, and being brightly lit, attracted large numbers of midges which congregated on the woodwork in the neighbourhood of lamps and were thus easily secured. The collection, which was brought home to England before being examined, was not rich in CERATOPOGONINAE, but an account of such species as were contained in it may be of some interest, because little appears to be known about the occurrence of these midges in Egypt.

Forcipomyia egypti, sp.n.

Length of body* (one female), 1·4 mm. ; length of wing, 1·2 mm. ; greatest breadth of wing, 0·5 mm. Without scales.

Head dark brown, occiput bearing long dark hairs which overhang the eyes. Eyes bare, broadly contiguous above. Clypeus and proboscis dark brown. Palpi (fig. 1, *a*) dark brown ; first segment small, second and fourth subequal, third as long as the fourth and fifth together, slightly inflated in the middle, furnished with a small sensory pit in which are a few short sensory hairs, fourth and fifth partly fused, the latter quite small. The palpi resemble those of *F. ingrami*. Mouth-parts well chitinised ; mandibles armed distally with numerous very small teeth. *Antennae* short, dark brown ; hairs short, dark brown ; both long and short spines on all the

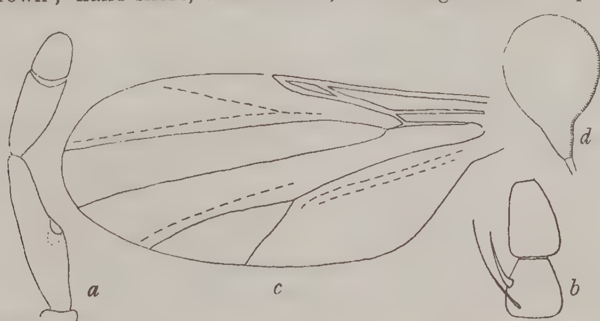

Fig. 1. *Forcipomyia egypti*, sp.n., outlines of various parts of ♀ : *a*, terminal segments of palp, × 300 ; *b*, tenth and eleventh segments of antenna, showing one hair and a long spine, × 300 ; *c*, wing (from a stained specimen), × 60 ; *d*, spermatheca, × 300.

flagellum segments, but the long spines on the eight proximal segments are particularly prominent, stout, curved, and as long as the segments. First segment a ring of dark chitin bearing a number of stout hairs. Torus subspherical, bearing a few short hairs. Flagellum segments forming an almost continuous series from base to apex, that is gradually elongating slightly but without any very abrupt change of shape between the tenth and eleventh segments (fig. 1, *b*). Segments 4 to 10 subspherical, the fourth being slightly broader than long and the tenth slightly longer than broad ; whorls composed of about ten hairs twice as long as the segments. Segments 11 to 15 oval to subcylindrical, tapering very slightly towards the apices, the length less than twice the breadth (*e.g.* in one instance the ratio of length to breadth being

* In all cases this measurement is taken from the anterior margin of the thorax to the tip of the abdomen of specimens mounted in pure carbolic acid.

10 to 7 in the case of the eleventh segment and 15 to 8 in the case of the fifteenth); the last segment ending in a nipple-like process. The ratio of the combined length of segments 4 to 10 to that of segments 11 to 15 (including the stylet) is about 1 to 1·1. *Thorax* almost uniformly dark brown, with a greyish pubescence; hairs brown. Pleurae darkish brown. Scutellum yellowish brown; bearing a transverse row of about nine large, brown, marginal bristles, and numerous (about fifteen) smaller hairs, some of which, however, are rather large. Post-scutellum dark brown, with a greyish pubescence. *Wings* (fig. 1, *c*) unadorned, that is without either pale or dark spots or patches; densely clothed all over with macrotrichia in addition to minute surface hairs, but with the usual small patch without macrotrichia just beyond the end of the costa. First and third veins fused or contiguous proximally so that the proximal cell is obsolete; distal cell well formed, triangular. Third vein reaching the costa about the middle of the wing. Fourth vein with a short petiole (about as long as the cross-vein) and long rami, the proximal ends of which are almost obsolete and can scarcely be distinguished without staining. Bifurcation of the fifth vein at about the same level as the distal end of the third vein. Halteres with ivory-white knobs and infuscated stems. *Legs* pale brown, almost uniformly coloured except for slight infuscation on the last tarsal segments. Femora unarmed. First tarsal segment on all the legs slightly longer than the second (about once and a half the length) but shorter than the combined length of the three following segments; fourth subcylindrical; fifth not elongated, unarmed. Claws simple, equal, strongly curved, delicate, rather more than half the length of the fifth tarsal segment. Empodium nearly as long as the claws, hairy. *Abdomen* uniformly dark brown dorsally, paler brown ventrally; sparsely clothed dorsally with rather long, dark brown hairs. Spermathecae (fig. 1, *d*) two, highly chitinised, subequal, pyriform, the diameter of the distal, subspherical portion about 50μ, the proximal portion conical, about 18μ long, terminating in the duct.

Egypt: Nile, near Ayat, 11.xii.1923, 2♀♀; near Beni-Hassan, 12.xii.1923, 2♀♀; at Assuan, 22.xii.1923, 1♀.

This species resembles the West African *Forcipomyia ingrami*, Carter, 1919, and several other allied species, but may be distinguished from them by, amongst other characters, the length of the terminal segments (11 to 15) of the antenna of the female, and the length of the first tarsal segment of the hind legs. For example, in *F. ingrami*, *F.* (*C.*) *rufescens* (Kieff.), 1918, a Tunisian species, and *F. coprophila*, Kieff., 1914, a very dark-coloured European species, the terminal segments of the antenna are longer, about twice as long as broad, and in *F. seneveti*, Kieff., 1922 (and *F. seneveti* var. *biskraensis*, Kieff., 1923), a species found at Algiers, the first tarsal segment of the hind legs is longer, namely, longer than the three following segments together.

Forcipomyia nilotheres, sp.n.

Length of body, 2·4 mm.; length of wing, 1·9 mm.; greatest breadth of wing, 0·75 mm.

Head dark brown: occiput dark brown, with numerous long hairs; clypeus dark brown. Eyes bare, broadly contiguous above. Proboscis dark brown; mouth-parts well chitinised, mandibles armed anteriorly with numerous small teeth. Palpi dark brown; second segment a little longer than the fifth and a little shorter than the fourth; third longer than the fourth and fifth together, its anterior third narrow, its posterior two-thirds greatly inflated on the inner side, ovoid, furnished with a large, elliptical sensory pit with a relatively small, anterior opening. *Antennae* dark brown, the five distal segments of the flagellum darker than the rest. Segments 3 to 10 bearing whorls of fifteen dark brown hairs, and also stout, curved spines, which are colourless and reach to about the middle of the succeeding segment. First segment dark brown, bearing rather long hairs. Torus dark brown, subspherical, bearing about half a dozen small hairs. Third segment globular, larger than the fourth, with

a short stalk. Segments 4 to 10 subspherical to oval, subequal, but successively diminishing slightly in breadth and becoming a little more constricted apically. Segments 11 to 14 subcylindrical, elongated, subequal, about three times as long as broad, with a distinct neck ; the fifteenth segment longer, over four times as long as broad, broader, ending in a small nipple-like process. The combined length of segments 11 to 15 greater than the combined length of segments 4 to 10, or 3 to 10, but not twice as great, about once and a half the combined length of segments 4 to 10. *Thorax* uniformly rather dark brown, scutum densely clothed with long hairs, some of which are pale, yellowish, and with long, dark, striated scales. Scutellum slightly paler brown than the scutum, bearing numerous long setae and shorter hairs. Postscutellum dark brown. Pleurae darkish brown. *Wings* dark, especially along the anterior border ; unadorned but for a pale, buff-coloured area at the base. Wing surface covered with microtrichia and densely clothed all over with dark macrotrichia, which are especially numerous at the anterior margin and at the tip. Long, slender, dark-coloured scales marked with longitudinal striations and with long petioles are present on the costa and the anterior veins. First and third veins fused basally, but forming a long, narrow distal cell. Third vein reaching the costa just beyond the middle of the wing. Fourth vein with a short petiole, slightly shorter than the cross-vein. Bifurcation of the fifth vein about the level of the base of the distal radial cell. Halteres with creamy-white knobs. *Legs* uniformly brown, without either dark or pale bands, bearing long hairs. Intermixed with the hairs on the proximal segments are long, slender, striated scales of a dark colour, which are conspicuous on the lower surfaces of the tibiae of all the legs. Femora unarmed. First tarsal segment shorter than the second on all the legs : about three-quarters the length on the forelegs, half the length on the middle legs, and two-thirds the length on the hind legs. Fourth tarsal segment cylindrical, fifth unarmed. Claws equal, simple, strongly curved, about half the length of the fifth tarsal segment. Empodium as long as the claws, hairy. *Abdomen* dark brown, the proximal third of the venter, however, paler brown, clothed with long, pale hairs, which are especially long at the posterior extremity, and long, slender, striated scales which are almost black and are very numerous laterally. Spermathecae two, very highly chitinised, pyriform, relatively small, diameters about 38μ and 48μ ; the commencement of the duct chitinised for a short distance, about 12μ.

EGYPT : Nile at Assiut, 14.xii.1923, 1♀.

This species resembles rather closely the West African *F. inornatipennis* (Aust.), in the female of which, however, the terminal segments of the antenna are longer, about four times as long as broad, the first tarsal segment of the hind legs is shorter, only about half the length of the second, and the spermathecae are larger and oval.

Atrichopogon atriscapula, Kieff.

Length of body (two females), 1·9 mm. ; length of wing, 1·5 mm. ; greatest breadth of wing, 0·6 mm.

Head dark brown ; occiput uniformly very dark brown, clypeus, proboscis, and palpi rather paler. Eyes contiguous above, the facets separated only by a narrow line ; bare, except at the extreme inner margin, where are some small hairs. Proboscis well developed ; mouth-parts highly chitinised, mandibles armed anteriorly with numerous (about 25) very small teeth. Palpi brown, the last segment darker than the rest, uniformly dark brown ; second, fourth, and fifth segments subequal ; third longer, not quite so long as the fourth and fifth together, a little swollen in the middle and furnished with a large sensory pit. *Antennae* dark brown, flagellum segments almost black. Whorls composed of about eight hairs approximately twice as long as the segments ; large, curved spines, longer than the segments, present on segments 3 to 10, and also shorter, straight spines. Torus dark brown, subspherical, bearing a number (about 12) of short hairs. Third segment considerably larger than

the fourth, with a short stalk. Segments 4 to 10 oval, slightly longer than broad, not constricted apically, subequal, the tenth being only slightly longer and narrower than the fourth (*e.g.* in one specimen 11 by 7 as compared with 10 by 9 units). Segments 11 to 14 subcylindrical, elongated, tapering slightly distally, approximately subequal, about three to three and a half times as long as broad; the fifteenth segment rather longer, five times as long as broad, tapering distally and ending in a rather long stylet. The combined length of segments 11 to 15 greater than that of segments 3 to 10, but not quite twice as great. *Thorax* with a dark brown median longitudinal stripe dorsally which is darkest anteriorly, on each side of it a shorter dark brown stripe deficient anteriorly, and still further laterally a small, narrow dark brown stripe; the general appearance of the thorax in dorsal view is therefore dark brown with paler brown or buff-coloured shoulders. Scutellum yellowish white or brownish white, that is yellowish brown and with the white pigment which it contains showing through; bearing two centro-marginal and two lateral bristles, and a number (about 16) of smaller hairs. Post-scutellum dark brown. *Wings* brownish, but otherwise without adornment. Wing surface entirely covered with rather large microtrichia, and bearing also longer, sparsely scattered macrotrichia, along the veins and over practically the whole wing with the exception of the radial and middle basal areas. Third vein about twice as long as the first, reaching the costa beyond the middle of the wing, namely at about two-thirds the length of the wing from the base and at about the same distance from the tip of the wing as the termination of the anterior branch of the fifth vein. First radial cell small, slit-like; second fully three times as long. Petiole of the fourth vein about as long as the cross-vein. Bifurcation of the fifth vein slightly distal to the level of the base of the first radial cell, and slightly distal to the bifurcation of the fourth vein. Halteres with white knobs. *Legs* brown, terminal tarsal segments infuscated on all the legs. Femora unarmed. First tarsal segment on all the legs more than twice as long as the second; fourth cylindrical; fifth unarmed. Claws small, equal, curved, simple. Empodium as long as the claws, hairy. *Abdomen* uniformly dark brown dorsally, paler brown ventrally. Spermathecae (fig. 2, *a*) two, very highly chitinised, oval, subequal, about 90μ by 80μ, the commencement of the duct narrow and chitinised for a considerable distance (30μ or 40μ). Eggs as seen in the abdomen of a female, long, elliptical, about 450μ by 130μ.

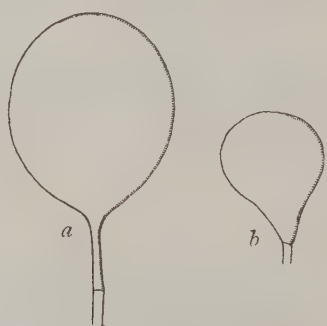

Fig. 2. Spermathecae ($\times$ 300) of: (*a*) *Atrichopogon atriscapula*, Kieff.; (*b*) *Neoceratopogon melanostictus* (I. & M.).

Egypt: Nile, near Beni-Hassan, 12.xii.1923, 3 ♀♀; near Girgeh, 15.xii.1923, 2 ♀♀; at Dendera, 16.xii.1923, 2 ♀♀; at Luxor, 17 to 20.xii.1923, 7 ♀♀; near Edfu, 21.xii.1923, 1 ♀; and at Cairo, 30.xii.1923, 1 ♀.

So far as can be judged from the short description given by Kieffer (1918), and from its resemblance in many respects to *A. albiscapula*, Kieff., this insect appears to be *A. atriscapula*, a species originally collected in Tunis.

Atrichopogon callipotami, sp.n.

Length of body, 2·0 mm.; length of wing, 1·7 mm.; greatest breadth of wing, 0·6 mm.

Resembling the preceding species, *A. atriscapula*, in many respects, but not so dark-coloured, and with less densely hairy wings. *Head* dark brown; occiput very dark, clypeus and proboscis slightly paler. Eyes hairy all over; narrowly separated above. Palpi darkish brown, especially the terminal segments; second segment a little longer than either the fourth or fifth, which are subequal; third not quite as long as the fourth and fifth together, swollen in the middle and furnished with a large sensory pit. *Antennae* very dark brown; basal segments of the flagellum (3 to 10) bearing whorls of about eight hairs, and both long spines, longer than the segments, and shorter, almost straight spines. First segment rather dark brown, bearing a few stout hairs. Torus very dark brown, almost black, subspherical, bearing a few stout hairs. Flagellum segments uniformly very dark brown, almost black. Segments 4 to 10 subspherical, subequal. Segments 11 to 14 subcylindrical, elongated, tapering slightly distally, about three times as long as broad; segment 15 longer, about five times as long as broad, tapering more notably, and ending in a rather long stylet. The combined length of segments 11 to 15 more than twice the combined length of segments 4 to 10, the ratio being about 25 to 11, but not quite twice as long as the combined length of segments 3 to 10. *Thorax* brownish, with three dark brown longitudinal stripes dorsally. The median stripe is the broadest and is darkest anteriorly, but it also deepens in colour again just in front of the scutellum so as to form a large, rounded, dark brown patch. The two lateral stripes are deficient anteriorly, the shoulders being therefore pale-coloured, brown. There is no small narrow stripe external to the lateral stripes as in *A. atriscapula*, but just anterior to the end of the inner margin of the lateral stripe on each side is a small oval dark mark. Pleurae darkish brown. Scutellum brown, containing some white pigment; bearing two centro-marginal and two lateral bristles, and several (about nine) smaller hairs. Post-scutellum dark brown. *Wings* pale brownish, unadorned. Entire wing surface covered by rather large microtrichia, and bearing also scattered macrotrichia distributed as follows: a considerable number along the anterior margin beyond the costa and at the tip of the wing extending back as far as the fork of the intercalary vein, along both rami of the fourth vein and over the distal two-thirds of the space enclosed between them, between the fourth and fifth veins from the wing margin to a point not quite as far back as the fork of the fifth vein, along the distal end of the fifth vein and the whole length of its rami, a few between the rami of the fifth vein, a row along the intercalary vein posterior to the fifth, and a few in the anal angle. Third vein nearly three times as long as the first, joining the costa about three-quarters of the length of the wing from its base. First radial cell small and narrow, second three times as long and broader. Petiole of the fourth vein shorter than the transverse vein. Anterior branch of the fifth vein and costa ending about equally distant from the tip of the wing. Fork of the fifth vein a little distal to the level of the base of the first radial cell. Halteres with white knobs. *Legs* brown, terminal tarsal segments somewhat infuscated. First tarsal segment on all the legs about three times as long as the second. Claws small, simple, curved, equal, about half the length of the fifth tarsal segment. Empodium as long as the claws, hairy. *Abdomen* brown, venter paler. Spermatheca single, highly chitinised, pyriform, length about 90μ, greatest breadth about 55μ, tapering gradually to pass into the duct. There are numerous small pale spots on the spermatheca, especially near the base.

EGYPT: Nile at Cairo, 30.xii.1923, 1 ♀.

This insect apparently resembles closely *A. kribiensis*, Kieff., a species found in the Cameroons, West Africa, but is browner, and may be distinguished from it by a number of minor characters, such as the wider distribution of macrotrichia on the wings and the greater lengths of the last five segments of the antennae.

Atrichopogon homoius, I. & M.

Egypt : Nile near Ayat, 11.xii.1923, 1 ♀ ; near Beni-Hassan, 12.xii. 1923, 2 ♀♀ ; at Assiut, 14.xii.1923, 22 ♀♀ ; near Girgeh, 15.xii.1923, 1 ♀ ; at Dendera, 16.xii.1923, 6 ♀♀ ; and at Assuan, 22.xii.1923, 1 ♀.

Atrichopogon fuscus (Meig.).

Egypt : Nile at Assiut, 14.xii.1923, 1 ♂.

The identification of this insect is uncertain because the specimen was damaged and had lost both antennae. For this reason no further description is given, but so far as could be judged it appeared to be *A. fuscus*.

Culicoides distinctipennis, Aust. var. **egypti,** n.

The single specimen collected, a female, differed from typical examples of *C. distinctipennis* in having the pale spot on the wing immediately distal to the costa divided, much as in *C. praetermissus*. The single spermatheca, however, was of the usual peg-top shape.

Egypt : Nile at Assiut, 14.xii.1923, 1 ♀.

Culicoides schultzei, End.

Egypt : Nile near Ayat, 11.xii.1923, 1 ♀ ; at Assiut, 14.xii.1923, 5 ♀, 3 ♂ ; and at Cairo, 30.xii.1923, 1 ♀.

Neoceratopogon* melanostictus (I. & M.).

Length of body (one female), 1·5 mm. ; length of wing, 1·3 mm. ; greatest breadth of wing, 0·5 mm.

The general characters of this insect, which appears to be the female of *N. melanostictus*, a species previously known from only a single male collected at Accra, on the Gold Coast, West Africa, are those of the genus (see Annals of Trop. Med. and Parasitol., xiv, p. 309). *Head* brown, occiput pale yellow with small brown spots or patches mostly at the points of insertion of the hairs. Eyes bare, separated above by a wedge-shaped area. Clypeus darkish brown, with four or five small hairs on each side. Proboscis pale brown ; mouth-parts well chitinised, much as in *N. marmoratus*. Palpi brown, darker at the distal end ; second, third, and fourth segments subequal, fifth longer and dilated at its end. *Antennae* pale-coloured, brownish ; the last five segments darker than the rest and infuscated all over, the first eight flagellum segments infuscated only at their apices. All the flagellum segments bear long spines which are delicate and almost straight. First segment almost colourless. Torus pale brown, subspherical, bearing a few hairs. Segments 4 to 10 from oval to flask-shaped, almost twice as long as broad. Segments 11 to 15 longer, subcylindrical, nearly three times as long as broad, the last segment the longest and ending in a conical process. *Thorax* cream-yellow dorsally, with numerous small, round, dark brown spots which correspond with the insertions of hairs, the arrangement of the spots being similar to those of *Culicoides adersi*. Pleurae dark brown with cream-yellow markings. Scutellum dark brown in the middle, paler (yellowish) laterally, containing pigment similar to that seen also in the thorax and abdomen ; bearing two centro-marginal bristles and two other bristles, one on each side of the middle line, a little more anteriorly and laterally, all four bristles, as in the male, being situated on the middle third of the scutellum. Post-scutellum dark brown. *Wings* hyaline,

* Notwithstanding certain differences in the generic definitions, it appears that our *Thysanognathus* (*Prionognathus*) must be regarded as a synonym of Malloch's *Neoceratopogon;* for Mr. W. A. Hoffman, who has examined *N. bellus*, the type species of Malloch's genus, and has compared it with the description of our type species, has very kindly informed us that the two appear to be congeneric.

with numerous black and grey spots and a yellowish area covering the anterior proximal part of the wing. The main spots are as in the male. In addition there are a few small, paler spots not present in the male (or at any rate not present in the single male hitherto examined), namely, at the distal extremities of the branches of the fourth and fifth veins, between the branches of the fifth vein near the point of bifurcation, and in the anal angle near the end of the posterior branch of the fifth vein. Venation as in the male. Wing surface devoid of microtrichia but with macrotichia over the whole of the distal half of the wing and along the distal posterior portion of the anal angle, but not extending to the base of the wing between the fourth and fifth veins. Halteres with yellowish knobs. *Legs* pale, yellowish, with dark brown bands, the adornment being much as in *N. marmoratus* except that the tarsi are paler, the hind tarsi only being somewhat infuscated. Claws long, unequal, as usual in the genus. *Abdomen* more yellowish than in the male, the dorsum being almost entirely cream-yellow, but showing a narrow, brownish, median, longitudinal stripe, and brown markings on the proximal part of the seventh segment. The yellow colour is due to a pigment contained in the body. Cerci cream-yellow. Spermatheca (fig. 2, *b*) single, highly chitinised, pyriform, diameter of the distal, subspherical, portion about 50μ.

Egypt : Nile, near Ayat, 11.xii.1923, 1 ♀; Nile, near Beni-Hassan, 12.xii.1923, 1 ♀.

The difference between the two females collected in Egypt and the single male collected in the Gold Coast are striking, for example, in size, the amount of yellow pigmentation on the head, thorax, and abdomen, and the number and distribution of the hairs and black spots on the wings, and assuming that we are correct in regarding them as merely sexual, indicate that the Egyptian race is larger and more highly adorned than that of West Africa.

A NEW CHALCID ATTACKING BAMBOO IN INDIA (HYMENOPTERA).

By J. Waterston, B.D., D.Sc.

Eurytoma chrysothrix, sp.n.

♀. Black, except as follows: funicle piceous, base of 6th (8th) tergite dark brownish; scape, pedicel and ring-joint, trochanters, femora and tibiae ferruginous; tarsi much paler; pubescence pale brown to nearly golden (on head) and on funicle paler. The head and thorax somewhat dull; abdomen shining, except on the ventral overlap of tergite 4 (6) and on tergite 6 (8).

Head, from above (across the eyes), over twice as broad as long, vertex about three-fifths the breadth; from in front, wider than deep (8 : 7). Toruli midway between posterior ocelli and mouth-edge. Eyes bare, as long as one-half the depth. The width across the eyes distinctly exceeds that of the prothorax and, slightly, the greatest thoracic breadth (between the tegulae). Ocelli in an obtuse-angled triangle; lateral pair at about one and a half diameters from the orbit; the anterior ocellus outside the scapal hollow. Vertex and upper face (at sides) down to nearly the level of the toruli with large umbilicate punctures.

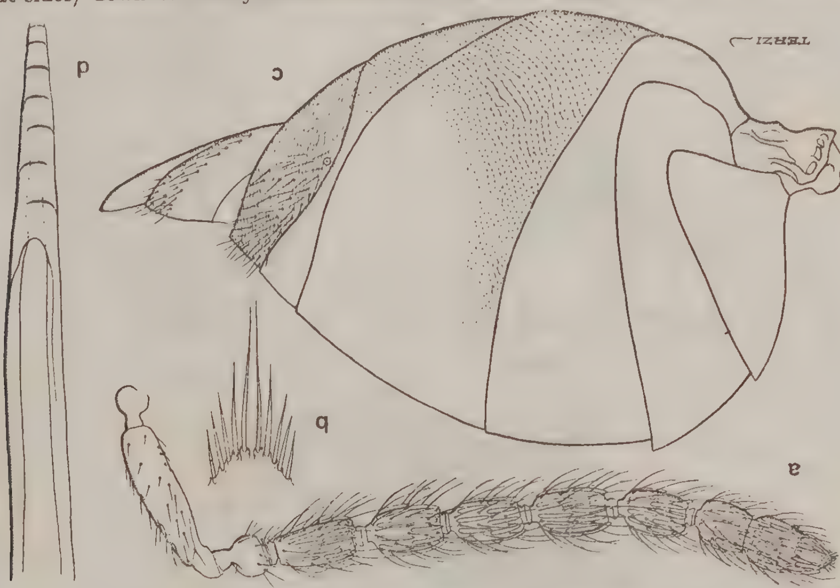

Fig. 1. *Eurytoma chrysothrix*, sp.n., ♀: *a*, antenna; *b*, labrum; *c*, abdomen, in profile; *d*, tip of ovipositor, dorsal view.

A strong keel runs downward from each lateral ocellus parallel with the orbit, from which it is separated by a shallow sulcus; beyond the lower edge of the eye this keel ceases to run parallel, and descending to about twice its previous distance from the orbit turns angularly towards the gena, where it becomes indistinct. On the lower face a number (7–9 on each side) of fine ridges converge on the mouth-edge, the strongest being (*a*) from the lower angle of the orbital keel and (*b*) from each torulus. Scapal hollows forming a single shining moderately deep excavation limited by a definite low carina passing beneath the anterior ocellus. At the upper end this hollow shows 1–2 incipient umbilicate punctures. Mouth contracted and its edge medianly inflected. Subtorular space nearly smooth, scantily pubescent, the lateral striate areas with numerous fine punctures and somewhat dense pubescence.

Antenna (fig. 1, *a*) about 1·5 mm. long. The bulla proximally expanded and bulb-like. Scape (about 4 : 1) as long as the first two funicular joints together or slightly longer than pedicel, ring-joint and first funicular, contracted at extreme apex to form a deep socket joint for pedicel, very roughly sculptured along dorsal edge on distal half. Pedicel (6 : 5) goblet-shaped and basally greatly constricted. Funicle, proportions of joints 11 : 10 : 10 : 10 : 9·5, and club 7·5 : 6 : 4·5; width about $5\frac{1}{2}$ on funicle rising to nearly 8 on first joint of club. Funicular joints with short necks at each end, the proximal neck being cylindrical and the other expanding distally to receive the proximal neck of the succeeding joint; 2nd club suture not distinct. Sensoria: 2 rows on each funicular and club joint, the free distal portion of the sensorium as long as the base. Labrum (fig. 1, *b*) subtriangular, broader than long (4 : 3), with 10 bristles of which 4 on each side are shorter and flatter and the apical pair more slender, at least one and a half times as long as the sclerite itself.

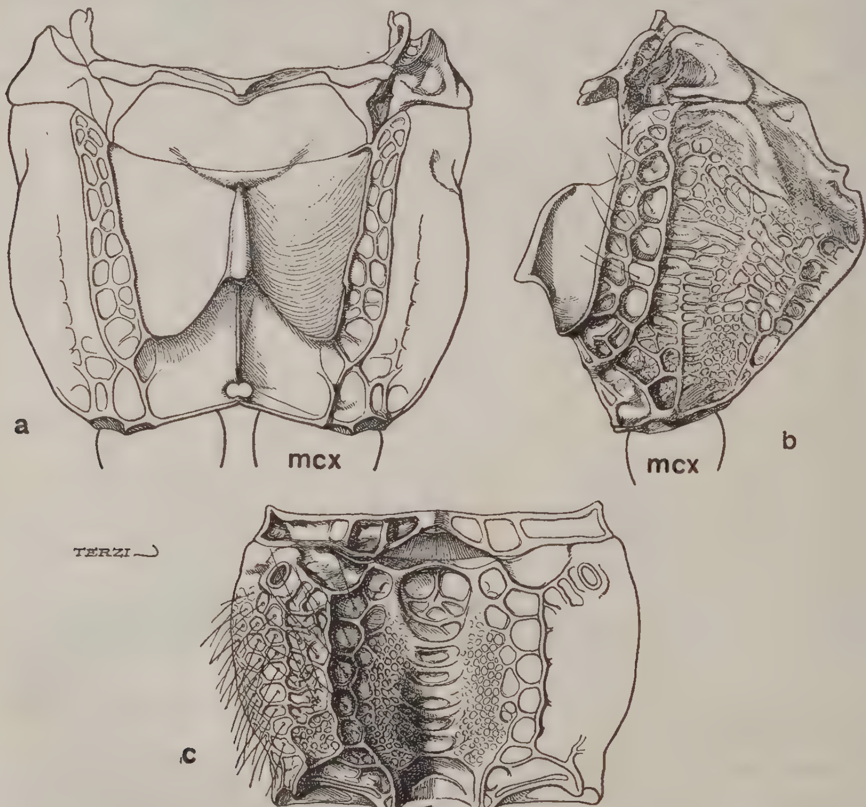

Fig. 2. *Eurytoma chrysothrix*, sp.n., ♀: *a*, mesothorax, ventral view; *b*, mesothorax, in profile; *mcx*, middle coxa; *c*, propodeon.

Mandibles (10 : 7) with 3 teeth and a thick rounded cutting edge above; 2 lower teeth short, acute, subequal; the third tooth (uppermost) shorter and rounded, the thickened cutting edge not reaching the base of the mandible superiorly but distinctly constricted. Stipes with about 20 bristles; maxillary palpi, 6, 5, 7, 16, last joint with about 12 bristles; labial palpi, 9, 4, 9, last joint with 8–9 bristles.

Thorax with head and propodeon distinctly longer than abdomen ; with propodeon alone, very slightly exceeded by the abdomen. Prothorax twice as broad as long, its length compared with those of scutum and scutellum in ratio 3 : 3 : 4. Antero-lateral prothoracic angles distinct. From any point above, the scutellum appears longer than the propodeon, but when dissected the two are practically equal ; whole notal surface of thorax with strong umbilicate punctures. Tegulae transversely rugose. Mesopleurae (fig. 2, *b*). Mesosternopleurae (fig. 2, *a*). On the sternum the impression of the anterior coxae reaches back (laterally) to about three-fourths from the prepectora to the insertion of the mid coxae. There is a strong high median ridge reaching to nearly one-half, and it is continued as a fine keel to the hind edge of the unmodified part of the sternum. Metathorax and propodeon (fig. 2, *c*) ; the metathorax at its longest (mid line) one-fourth the propodeon ; mid area posteriorly with a broad triangular depression which is deepest in front of the propodeon, and anteriorly with two small triangular hollows separated by a shining median elevation. Side areas on outer half undivided but with two or three short longitudinal ridges on the admedian half, forming as many small cells of which that nearest the mid line is largest. Propodeon medianly broadly depressed, the mid line crenulate, the hollows being transversely elongate. The most anterior of the hollows is the largest and sub-divided ; surface on each side of the crenulate line coarsely raised reticulate. Beyond this the propodeon is covered with polygonal cells formed by irregularly intersecting ridges, which, however, form a nearly straight keel on each side of the median depression.

Forewings (2 : 1), length about 2·4 mm. Submarginal, marginal, radius, post-marginal in ratio 100 : 28 : 16 : 25. Submarginal with 16 bristles in a single row up to the three clear pustules, and 3 or 4 (double) beyond ; a dozen short bristles on radius and its knob. Hind wings (10 : 3), length about 1·7 mm.

Coxae in fore legs with large almost umbilicate punctures along anterior edge, in hind legs very coarsely punctate anteriorly (ventrally). In mid and fore legs the first tarsal joint twice the second in length.

Abdomen (fig. 1, *c*) strongly compressed, smooth, a little roughened on tergite 4 (6) as indicated in fig. Petiole very short, transverse, projecting shortly and bluntly at sides. On dorsal surface with a shining hollow and ventrally with three such hollows, longer, like short furrows. Valve of ovipositor shining, bare, at extreme apex finely channelled, with about 6 bristles ventrally on apical third and about a dozen (minute) on apex itself. Ovipositor tip (fig. 1, *d*) slender, with about 8 teeth, the apical 4 being transverse and entire.

Length about 3·75 mm. ; alar expanse 5·5 mm.

Holotype ♀ in British Museum ; one of a series of 4 ♀ (one damaged) bred from bamboo, Walayar Forest, South India (*T. V. Ramakrishna Ayyar*).

This species should be easily recognisable by (*a*) the colour of the pubescence and legs, (*b*) the sculpture of the head, (*c*) the simple anterior coxae, (*d*) the mesosternum and propodeon, and (*e*) the teeth on the ovipositor. Except in the striation of the lower face, in which it resembles *E. strigifrons*, Thoms. (1875), *E. chrysothrix*, sp.n., is unlike any Palaearctic species known to me. I have examined the types of a number of Cameron's Oriental *Eurytoma* without, however, finding any sufficiently resembling the present insect to warrant a detailed comparison.

FURTHER NOTES ON THE ETHIOPIAN FRUIT-FLIES, WITH KEYS TO ALL THE KNOWN GENERA AND SPECIES.

By Prof. M. Bezzi,
Turin, Italy.

With the new material received from the Imperial Bureau of Entomology through the courtesy of Dr. Guy A. K. Marshall, I am now able to complete my previous notes on the Ethiopian Trypaneidae.*

In order to offer a complete synopsis of all the species at present known from the Ethiopian Region, numbering to-day about 390, I have incorporated in the present work all the new forms which I have received from other sources: (*a*) from the South African Museum, Capetown; (*b*) from Mr. H. K. Munro, East London, South Africa; (*c*) from the Museum d'Histoire Naturelle, Paris; (*d*) from the Musée du Congo Belge, Tervueren; (*e*) from the Hungarian Museum, Budapest. The full descriptions of these species will appear in other forthcoming papers.

I have also included all the species described by Dr. G. Enderlein, of Berlin, in a recent paper,† though they are mostly known to me only from descriptions.

For abbreviations used in the following pages see Bull. Ent. Res. viii, 1918, p. 216, to which must be added :—

poc.=praeocellar,

for the bristles to be found in the middle of the frontal stripe in some Schistopterinae.

*   *   *   *

1 (12). Ocp. quite wanting; thoracic chaetotaxy incomplete, hm., prst., dc. and st. being always wanting; front femora without bristles below.

2 (7). Wings with the first three longitudinal veins closely approximated, the anterior cross-vein long and oblique, the second basal cell dilated and always hyaline, and the anal cell drawn out into a very long point; arista bare; abdomen usually short and broad, and often broader than the thorax ... ... Subfam. Dacinae.

3 (6). Prsc. wanting; wings of male without anal lobe.

4 (5). Three sa., the anterior one being well developed ... 1. *Tridacus*, Bezzi.

5 (4). Only two sa., the anterior one being quite wanting 2. *Dacus*, F. (*s. str.*)

6 (3). Prsc. present; wings of male with well developed anal lobe 3. *Afrodacus*, Bezzi.

7 (2). Wings with the first three veins not so approximated, the anterior cross-vein short and perpendicular, the second basal cell not dilated and the anal cell with a short point; arista usually plumose; abdomen long and linear, narrower than the thorax ... ... Subfam. Adraminae,

8 (11). Femora spinose beneath; antennae much longer than the face.

9 (10). Thoracic suture complete; arista plumose; only two scutellar bristles 4. *Meracanthomyia*, Hend.

10 (9). Thoracic suture interrupted in the middle; arista bare; scutellum quadrisetose ... ... 5. *Munromyia*, Bezzi.

11 (8). Femora not spinose beneath; thoracic suture interrupted; antennae shorter than the face; arista plumose ... 6. *Sosiopsila*, Bezzi.

12 (1). Ocp. always present, even if sometimes a few only; thoracic chaetotaxy complete, that is the above-named bristles usually present, or at least not all wanting at the same time; front femora with bristles below.

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* i, Bull. Ent. Res., vi, 1915, pp. 85–101; ii, l. c., viii, 1917, pp. 63–71; iii, l. c., ix, 1919, pp. 177–182; iv, l.c., viii, 1918, pp. 215–251; v, l. c., ix, 1918, pp. 13–46; vi, l. c., x. 1920, pp. 211–271.

† Zur Kenntnis Tropischer Frucht-Bohrfliegen. Zool. Jahrb. xliii, Abt. f. Syst., 1920, pp. 336—360.

13 (146). Wings with the costa not broadly interrupted at end of the auxiliary vein and destitute of peculiarly coloured " bullae " on the disc ; poc. always wanting ; third antennal joint not subulate, even if sometimes with a point on its upper terminal corner ; oc. if present approximate at base and diverging ; s. or. placed in a line not or but slightly converging towards the middle of the front.

14 (115). Ocp. composed of thin and acute bristles, which usually are of a black colour ; in doubtful cases, either the antennal arista is plumose, or the scp. are well developed, or the dc. are placed much behind the suture, or the third longitudinal vein is bristly, or the point of the anal cell is long, or the wing-pattern is not reticulate, or the thorax and scutellum show a striking coloration ... ... Subfam. CERATITINAE.

15 (20). Ocp. reduced to 2—3 only and limited to the upper part of the occiput ; prst. and st. wanting ; third longitudinal vein bristly ; femora not spinose beneath ; anal cell with a short point ; face very concave ; middle tibiae with two terminal spurs.

16 (19). Dc. wanting.

17 (18). Thoracic suture complete ; two scutellar bristles only ; arista shortly pilose ; no distinct mpl. ... ... 7. *Trypanophion*, gen. nov.

18 (17). Thoracic suture broadly interrupted in the middle ; scutellum with four bristles ; arista bare ; mpl. well developed ... 8. *Coelopacidia*, End.

19 (16). Dc. present ... ... 9. *Stenotrypeta*, End.*

20 (15). Ocp. more numerous and forming a complete row ; prst., dc. and st. present, or at least not all wanting at the same time ; face flattened or even convex.

21 (22). Mesosternum clothed on the anterior half with short and numerous spine-like bristles ; dc. placed on the line of the a. sa. ; scutellum with two bristles ; abdomen compressed and rather curved 10. *Xaniosternum*, End.

22 (21). Mesosternum only with the usual row of bristles ; abdomen not compressed.

23 (26). Femora spinulose beneath ; arista shortly plumose ; third longitudinal vein with a few bristles only near its extreme base.

24 (25). Wings very broad, with the second and third longitudinal veins distinctly sinuous, the last portion of the third vein being moreover bent downwards at the end ... ... 11. *Conradtina*, End.

25 (24). Wings narrower, with the above-named veins not sinuous, and with the last portion of the third vein straight ... ... 12. *Celidodacus*, Hend.

26 (23). Femora not spinulose beneath.

27 (78). Third longitudinal vein bristly throughout its whole length, or at least from the base to the anterior cross-vein ; ocp. mostly black ; arista very often pilose or plumose ; scp. well developed ; lower angle of the anal cell mostly drawn out into a point which is longer than the second basal cell.

28 (77). Dc. placed on or behind the line of the a. sa., never much before this line.

29 (54). Dc. placed on or only a little behind the line of the a. sa. and thus not very far from the suture and distant from the scutellum.

30 (31). Body elongate, with very long and slender abdomen ; scutellum with four bristles ; no oc. ; only one i. or. ; hind cross-vein perpendicular
9. *Stenotrypeta*, End.†

31 (30). Body not so slender ; two or three i. or. ; oc. usually present ; anal cross-vein deeply bent in the middle.

32 (53). Middle scp. well developed ; legs short and stout ; wings of broader shape, adorned with transverse or oblique bands and with the small cross-vein near the middle of the discoidal cell ; head not " balanced," with less developed lower swellings.

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* This genus is repeated at No. 30 ; it seems to be allied to *Coelotrypes* (see No. 84), which has, however, st. and bare third vein.

† In the character of the single i. or. this genus agrees with *Allotrypes* (see No. 92), which has, however, a bare third vein.

33 (36). Hind cross-vein outwardly oblique, that is, with its upper end more distant from the base of wing than the inferior one ; upper angle of discoidal cell therefore acute ; usually three strong i. or. ; eyes narrow ; occiput with rather developed lateral swellings below ; costal bristle strong ; basal dark band of wings oblique, beginning at fore border beyond the stigma.

34 (35). Body prevalently black, with striking yellow or white markings ; wings adorned with broad blackish oblique bands, and usually with a more or less complete Λ-shaped band at hind border 13. *Carpophthoromyia*, Aust.

35 (34). Body prevalently yellowish ; wings adorned with yellowish, partly infuscated, transverse bands ... ... 14. *Leucotaeniella*, Bezzi.

36 (33). Hind cross-vein inwardly oblique, its lower end being more remote from the wing base than the upper one ; the acute angle of the discoidal cell is therefore the lower one.

37 (42). Antennae short, with the second joint prominent and densely spinulose above ; costal bristle strong ; arista with long plumosity ; genal bristle strong.

38 (41). Third antennal joint distinctly pointed at end ; three o. ir.

39 (40). Basal segment of costa destitute of bristles before the costal one ; basal dark band of wings perpendicular, beginning at stigma ; body prevalently yellowish with black-spotted thorax ... ... 15. *Chelyophora*, Rond.

40 (39). Basal segment of costa provided with two groups of strong bristles before the costal one ; basal band oblique, beginning at fore border beyond the stigma ... ... 16. *Bistrispinaria*, Speis.

41 (38). Third antennal joint rounded at end ; only two i. or. ; basal dark band of the wings oblique, beginning at fore border beyond the stigma. 17. *Clinotaenia*, Bezzi.*

42 (37). Antennae not, or but little, shortened, with the second joint not prominent, never spinulose above ; costal bristle short and little developed ; only two i. or. as a rule ; arista more shortly plumose or pubescent only ; genal bristle much less developed ; basal dark band of the wings perpendicular, beginning at stigma.

43 (52). Head, in side view, less shortened, the eyes being therefore more rounded ; thorax and scutellum prevalently yellowish or reddish, or densely grey-dusted, with black spots (when the thorax is shining black, the scutellum is yellow and not spotted) ; wings with yellowish bands, which are only exceptionally broadly infuscated, and with blackish basal streaks ; the band passing over the hind cross-vein is not, or only exceptionally, united with the basal one.

44 (45). Arista with short pubescence, which is more distinct on the upper side ; frons of the male with conspicuous spathulate appendages ; marginal band of wings isolated... ... ... 18. *Ceratitis*, MacLeay (s. str.).

45 (44). Arista with longer pubescence or even with short plumosity, equally developed on both sides ; frons of the male without such appendages.

46 (51). Frons flat, normally shaped, with rather thin s. or., which are inserted on less distinct and less converging plates.

47 (48). Middle legs of the male broadly feathered, at least on the tibiae ; wings with the dark marginal band separated from the basal one beyond the stigma ... ... 19. *Pterandrus*, Bezzi.

48 (47). Middle legs of male simple ; marginal band typically united with the basal one.

49 (50). Scutellum rounded, swollen, without distinct lateral keels, more or less distinctly trilobate and black-spotted, like that of the two preceding genera ; body yellowish, with black-spotted thorax ... 20. *Pardalaspis*, Bezzi.

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* *Trirhithrum albonigrum*, End., may fall here, but has three i. or., and the basal dark band of wing perpendicular, beginning at stigma.

50 (49). Scutellum flat and bluntly triangular, with distinct lateral keels and entirely yellow, not spotted ; body shining black or shining red, never black-spotted ... ... 21. *Perilampsis*, Bezzi.

51 (46). Frons with very stout s. or., which are inserted on well-developed and converging plates, which are, moreover, very prominent and cristate in the male ... ... 22. *Hoplolopha*, Bezzi.

52 (43). Head distinctly shortened in side view, the eyes being narrower ; thorax and scutellum shining black, sometimes with whitish markings, or even the scutellum white with black spots ; arista with long plumosity ; wings with blackish bands radiating from the base, which is typically destitute of streaks... ... ... 23. *Trirhithrum*, Bezzi.

53 (32). No distinct middle scp. ; legs long and slender ; wings long and narrow, with the small cross-vein placed near the base of the discoidal cell, and adorned with yellowish longitudinal rays ; head " balanced," with narrow eyes and much developed lower occipital swellings
24. *Xanthorrhachista*, Hend.

54 (29). Dc. as a rule placed much behind the line of the a. sa., and therefore very far from the suture and very near to the scutellum ; eyes usually rounded ; lower occipital swellings absent or but little developed ; hind cross-vein outwardly oblique ; wing pattern never *Ceratitis*-like.

55 (58). Second longitudinal vein distinctly wavy ; scutellum with three pairs of bristles, the intermediate pair being often much smaller than the others ; arista usually plumose ; pterostigma elongate.

56 (57). St. wanting or very thin ; head much broader than the thorax ; middle scutellar bristles weaker ; third and fourth longitudinal veins with their last portions parallel ; arista plumose... ... 25. *Themarictera*, Hend.

57 (56). St. present and strong ; head not or but little broader than the thorax ; middle scutellar bristles as strong as the others ; the above-named veins diverging distally ; arista plumose or pubescent 26. *Themara*, Walk.

58 (55). Second longitudinal vein straight ; pterostigma short.

59 (60). Scutellum with three pairs of bristles ; face with a longitudinal keel in the middle between the antennae ; proboscis much thickened ; lower angle of the anal cell drawn out into a very long point ; wing pattern approaching that of the reticulate type ... ... 27. *Baryglossa*, Bezzi.

60 (59). Scutellum with two pairs only of bristles.

61 (62). Ocp. very numerous, long and thick ; oc. rudimentary or wanting ; arista with long and scattered plumosity ; wings mostly black
28. *Ptiloniola*, Hend.

62 (60). Ocp. less numerous and thin ; arista usually bare or shortly pubescent, rarely with short plumosity ; wings banded, or spotted, or with the anterior half black ...

63 (64). No prst. and no oc. ; wings with the small cross-vein placed near the middle of the discoidal cell, and with the last portion of the fourth vein curved and diverging from the last portion of the third, adorned with a distinct whitish terminal spot ... ... 29. *Rhacochlaena*, Loew.

64 (63). Prst. always present ; oc. usually present, even if very little developed ; last portion of fourth vein not or less curved and not or very little diverging.

65 (70). Small cross-vein near or before the middle of the discoidal cell.

66 (67). Wings very broad towards their middle, with the costa rounded outwardly and with very short second posterior cell ; they are adorned with a broad rounded fuscous spot and with some curved dark bands ; oc. very long and strong ; dc. placed much behind the line of a. sa.
30. *Taomyia*, Bezzi.

67 (66). Wings of usual shape, with straight costa and with long second posterior cell ; they are adorned with fuscous, partly confluent bands or with isolated spots ; oc. short or wanting ; dc. not so far back.

68 (69). Oc. short ; head of male with normal bristles ... 31. *Phorellia*, R.D.
69 (68). Oc. wanting ; frons of male with horn-like bristles ; face not retreating ; proboscis with a prominent basal ridge ; front femora much thickened 32. *Hoplandromyia*, gen. nov.
70 (65). Small cross-vein beyond the middle of the discoidal cell, and often very near the hind cross-vein ; dc. placed much behind the line of the a. sa.
71 (72). Eyes in profile narrow, much higher than broad ; thorax black-spotted ; wings with yellow longitudinal stripes... ... 33. *Notomma*, Bezzi.
72 (71). Eyes in profile broad and rounded ; wings with blackish transverse bands, or with the anterior half, or more, entirely darkened.
73 (74). Wings of usual shape, as long as or shorter than the body, with short stigma and with distinct costal bristle ; oc. well developed ; frons narrow ; scutellum flat ; wings banded ... ... 34. *Pseudospheniscus*, Hend.
74 (73). Wings rather narrow and longer than the body, with parallel sides, with elongate stigma and without costal bristle ; oc. very thin or even wanting ; wings not banded, with the anterior half or more infuscated.
75 (76). Two strong mpl. and three i. or. ; antennae much shorter than the face, with bare arista ; pterostigma shorter than the second basal cell ; macrochaetae black ... ... 35. *Afrocneros*, gen. nov.
76 (75). Only one mpl. and only two i. or. ; antennae as long as the face, with pubescent arista ; pterostigma as long as or longer than the second costal cell ; macrochaetae mostly yellow ... ... 36. *Ocnerioxa*, Speis. (p.p.).
77 (28). Dc. placed much before the line of the a. sa., and thus very near the suture 57. *Pliomelaena*, Bezzi (p.p.).
78 (27). Third longitudinal vein quite bare or only with a few bristles near the base ; ocp. mostly whitish ; arista usually bare or shortly pubescent ; scp. sometimes less developed ; anal cell usually with a short point.
79 (86). Dc. placed much behind the line of the a. sa. ; ocp. always black.
80 (81). Wings narrow and long, with parallel sides, with very elongate stigma, and with the point of the anal cell a little longer than the second basal cell ; they are evenly infuscated on the anterior half or more 36. *Ocnerioxa*, Speis.
81 (80). Wings of usual shape, with shorter stigma, and with the point of the anal cell shorter than the second basal cell.
82 (83). Hind cross-vein in middle of wing, oblique outwardly, the lower angle of the very short discoidal cell therefore acute ; first longitudinal vein very short ; last portion of the fourth longitudinal vein about as long as the rest of the same vein ; frons narrow, much longer than broad 37. *Xanthanomaea*, Bezzi.
83 (82). Hind cross-vein much beyond the middle of wing, the last portion of the fourth vein being about half as long as the rest of the vein ; first vein normal ; front broad.
84 (85). No prst. ; only a few ocp. ; antennae longer than the face, which is very concave ; small cross-vein near middle of discoidal cell ; first posterior cell only a little dilated towards the end ; wings with isolated fuscous spots ... ... 38. *Coelotrypes*, Bezzi.
85 (84). Prst. present ; ocp. forming a complete row ; antennae shorter ; small cross-vein much beyond middle of discoidal cell ; first posterior cell suddenly dilated in its terminal half ; wings with elongate stigma and with longitudinal yellowish rays ... ... 39. *Hermannloewia*, Bezzi.
86 (79). Dc. placed before or on the line of the a. sa., sometimes only a little behind.
87 (90). Anal cell quite rounded outwardly, its lower angle being neither acute nor produced ; ocp. black.
88 (89). Wings of normal shape, entirely hyaline or with fuscous transverse bands.

a (*b*). Antennae much longer than the face ; fourth longitudinal vein bent downwards before small cross-vein ... ... 39*a*. *Zacerata*, Coq.

b (*a*). Antennae shorter than the face ; fourth vein straight 40. *Urophora*, R.D.

89 (88). Wings very narrow and long, with parallel sides and almost truncate at end, entirely infuscated, with numerous small subhyaline spots, forming a reticulation ... ... 53. *Elaphromyia*, Bigot (p.p.).

90 (87). Anal cell with the lower angle acute, and more or less produced into a short point.

91 (100). Body mostly yellowish or reddish, with or without black spots ; wings with yellowish bands or rays, or with fuscous spots, or wholly black, without hyaline indentations, or rarely with hyaline rounded spots.

92 (93). Only one i. or., which is very strong and curved backwards ; body reddish, unspotted ; ocp. black ; praetarsi elongate ; wings entirely black, without hyaline spots ... ... 41. *Allotrypes*, Bezzi.

93 (92). Two or three i. or., which are thin and curved inwardly ; body yellowish, often black-spotted ; ocp. whitish or yellowish ; praetarsi normal ; wings not black or with hyaline spots.

94 (95). No oc. ; small cross-vein at or before the middle of discoidal cell.

a (*b*). Fourth longitudinal vein quite straight before the small cross-vein ; hind cross-vein perpendicular ... ... 42. *Carpomyia*, A. Costa.

b (*a*). Fourth vein strongly curved downwards before the small cross-vein ; hind cross-vein outwardly oblique ... ... 43. *Rivelliomima*, Bezzi.

95 (94). Oc. well developed ; small cross-vein beyond the middle of the discoidal cell.

96 (97). Wings black, with hyaline rounded spots, of somewhat reticulate type 57. *Pliomelaena*, Bezzi (p.p.).

97 (96). Wings not so coloured.

98 (99). Eyes narrow, much higher than broad ; dc. on the line of the a. sa. ; prsc. as widely separated as the dc. ; first posterior cell narrowed at end ; wings with yellowish longitudinal rays 44. *Craspedoxantha*, Bezzi.

99 (98). Eyes rounded ; dc. before the line ; prsc. nearer together than the dc. ; first posterior cell not or but little narrowed at end ; wings with fuscous cross-bands or spots (*Sitarea*, R.D.) or quite hyaline (*Terellia*, *s. str.*) 45. *Terellia*, R.D.

100 (91). Body quite black, at the most only the abdomen reddish, at any rate thorax and scutellum never black-spotted ; wings dark brown or blackish, with hyaline spots and indentations.

101 (102). Head in front view higher than broad, with well-developed lower occipital swellings ; antennae very short, inserted above middle of eyes 46. *Brachyaciura*, Bezzi.

102 (101). Head in front view broader than high, with no distinct lower swellings ; antennae as long as the face or nearly so, inserted at or below middle of eyes.

103 (106). Small cross-vein placed very near the hind one and often on the same line with it ; mouth-border prominent, proboscis geniculate.

104 (105). Mouth-border very prominent ; proboscis very long ; thorax densely dusted and clothed with thick pubescence ; scutellum very convex, with 4 bristles ; ocp. long and whitish ; wings with confluent dark bands 47. *Rhynchoedaspis*, Bezzi.

105 (104). Mouth-border less prominent ; proboscis shorter ; thorax shining black, with thin, hardly visible pubescence ; scutellum flat above, with two bristles only ; ocp. short and black ; wings with separated dark bands 48. *Munroella*, Bezzi.

106 (103). Small cross-vein at a considerable distance from the hind one, the distance between them being longer than its own length ; mouth-border not or very slightly prominent ; proboscis short and simple, or shortly geniculate.

107 (110). Thorax more or less shining black, the ground-colour of the back not or little altered by the faint greyish pollen ; scutellum shorter than broad, usually with two bristles only.

108 (109). Species of greater size, with a very constant wing-pattern, consisting of two hyaline indentations at fore border and three at hind border 49. *Aciura*, R.D.

109 (108). Smaller species, with different wing pattern 50. *Sphensicomyia*, Bezzi.

110 (107). Thorax on the back densely clothed with greyish pollen, the ground-colour not or hardly visible ; scutellum flat, as long as broad, usually with strong a. sct.

111 (114). Wings of usual shape, with an *Aciura*-like pattern, without or with a few hyaline spots on the disc.

112 (113). Dc. placed on the line of the a. sa. or only a little before ; a. sct. long and strong ; proboscis short and simple ; wings with no apical hyaline spot and usually without hyaline spots on the disc (or at most with 1–3), not at all reticulate ... ... 51. *Tephrella*, Bezzi.

113 (112). Dc. placed very near the suture, much before the line of the a. sa. ; a. sct. wanting or small ; proboscis elongate and shortly geniculate ; wings typically with hyaline terminal spot and with more numerous hyaline spots on the disc, sometimes almost reticulate 58. *Spathulina*, Rond. (p.p.).

114 (111). Wings distinctly widened, rounded at end and narrow at base, with some hyaline spots in the middle ; dc. before the line 54. *Platensina*, End. (p.p.).

115 (14). Ocp. composed of strong and usually obtuse bristles, which are pale yellowish or whitish in colour, at least in part ; scp. mostly indistinct ; third longitudinal vein bare on the upper side, or exceptionally with a few bristles near the base only ; in doubtful cases, either the wings have a reticulate pattern, or the dc. are placed much before the line of the a. sa., or the lower point of anal cell is very short, or the arista is bare, or the coloration of body is much more modest, and entirely without striking markings ... ... Subfam. TRYPANEINAE.

116 (117). Wings with an *Aciura*-like pattern, that is, with two hyaline indentations at fore border and three or four at hind border 51. *Tephrella*, Bezzi (p.p.).

117 (116). Wings with a different pattern.

118 (119). Head much flattened, in front view much broader than high ; eyes narrow, their horizontal diameter being the longest ; wings almost entirely black 52. *Platomma*, Bezzi.

119 (118). Head not flattened, in front view higher than broad ; eyes rounded, with the longest diameter vertical.

120 (121). Wings very narrow and long, with parallel sides, almost truncate at end, and with the anal cell obtuse, its lower angle not being acute ; ocp. in part black ... ... 53. *Elaphromyia*, Big.

121 (120). Wings not so shaped, and with the lower angle of anal cell acute.

122 (123). Wings much widened and rounded outwardly, about as long as broad ; axillary cell very narrow ; only a few hyaline discal spots 54. *Platensina*, End.

123 (122). Wings not or but slightly widened, always longer than broad, with normal axillary cell ; if widened, there are numerous hyaline or subhyaline discal spots.

124 (125). Wings often widened, with numerous and usually minute hyaline or subhyaline spots on the disc, but not reticulate ; fore part of frons or face frequently with deep black spots 55. *Afreutreta*, gen. nov.

125 (124). Wings not so shaped, never so coloured; if widened, they are typically reticulate; frons and face without black spots.

126 (133). Wings with the black colour more extensive than the hyaline; hyaline discal spots very few in number, thus the wings not appearing reticulate.

127 (128). Wings with the black pattern distinctly radiating at apex and hind border; proboscis short and not geniculate 56. *Euaresta*, Loew.

128 (127). Wing pattern not distinctly radiating.

129 (130). Proboscis short and simple ... ... 57. *Pliomelaena*, Bezzi.

130 (129). Proboscis distinctly geniculate.

131 (132). Proboscis shorter than the head, with the terminal part short 58. *Spathulina*, Rond.

132 (131). Proboscis longer than the head, with the terminal part as long as or longer than the lower border of the head ... 60. *Ensina*, R. D. (p.p.).

133 (126). Wings with the hyaline part more extensive than the black, or appearing reticulate owing to the numerous broad hyaline discal spots, or having a complete middle band, or being dimidiate, or having a star-shaped terminal pattern.

134 (135). Wings with a complete dark median band, which includes the rather approximated cross-veins; proboscis geniculate 59. *Sphenella*, R.D.

135 (134). Wings not so coloured and with the cross-veins less approximated.

136 (137). Head depressed, considerably longer than high, with very narrow peristomialia; if head not so depressed, the proboscis very long and geniculate, its terminal part being as long as or longer than the lower border of head 60. *Ensina*, R.D.

137 (136). Head not depressed; proboscis usually short and simple; if the proboscis is geniculate, its terminal part is shorter than the basal one.

138 (143). Wings with a properly reticulate pattern, extended over all or almost all their surface.

139 (142). Frons flat, and not all or little produced above; ovipositor flat.

140 (141). Frons of usual breadth; antennae rather approximate; wings not at all widened, with the stigma unicolorous or with a single hyaline spot 61. *Euribia*, Meig.

141 (140). Frons very broad; antennae broadly separated; wings distinctly widened, usually with short radiating marginal streaks and with a bimaculate stigma ... ... 62. *Campiglossa*, Rond.

142 (139). Frons convex and prominent above; ovipositor conical 63. *Camaromyia*, Hend.

143 (138). Wing-pattern not extended over the greater part of the surface but either the hind or the basal part quite hyaline or very faintly reticulate.

144 (145). Wings dimidiate, that is, on the fore half with dark spots or a dark stripe, on the hind half either quite hyaline or with a very faint reticulation; pattern never star-shaped at the apex ... 64. *Acanthiophilus*, Beck.

145 (144). Wings with a star-shaped pattern on the terminal half, or at least with the pattern radiating at the apex ... ... 65. *Trypanea*, Schrank.

146 (13). Wings with the costa deeply interrupted at end of auxiliary vein, and there with a more or less distinct projection; if this character is less pronounced, there are poc.; wings adorned with strikingly coloured "bullae" on the disc; third antennal joint subulate; oc., if present, distant at base and parallel; s. or. placed in a line that runs obliquely towards middle of frons ... ... (Subfam. SCHISTOPTERINAE).

147 (154). Oc. strong; poc. usually present; ocp. thick and white, numerous; last portion of fourth longitudinal vein straight and normal; body and legs prevalently yellowish or reddish; wing-pattern of a more reticulate type.

148 (149). Wings very broad and rounded, with the first and the third longitudinal veins bristly, with the hind cross-vein exceedingly oblique in its lower half, and with the anal cell drawn out into a rather long point; poc. wanting ... ... 66. *Perirhithrum*, Bezzi.

149 (148). Wings of normal shape or much less dilated, with all the veins bare above, with the hind cross-vein regular, and with the lower angle of the anal cell not so produced; poc. present.

150 (151). Costal nick less developed; a black spot on each side of the root of the antennae; wing-pattern with close reticulation and paler apex 67. *Eutretosoma*, Hend.

151 (150). Costal nick well-developed; no black spots at sides of antennae; wing-pattern with less distinct reticulation and with radiating streaks at border.

152 (153). Only two i. or.; scutellum with two or four bristles; thorax and abdomen without erect supplementary bristles; wings mainly dark 68. *Rhabdochaeta*, De Meij.

153 (152). Two to four i. or.; scutellum with six bristles; thorax and abdomen with supernumerary erect bristles; wings mainly hyaline 69. *Rhochmopterum*, Speis.

154 (147). Oc. and poc. quite wanting; the white and thick ocp. are wanting or only represented by one or two pairs; last portion of fourth vein suddenly curved downwards before the end; body and legs prevalently black; lower angle of anal cell not produced; wing-pattern more of the rivulet type.

155 (156). Wings broad, with strongly curved sides; second vein short and strongly curved, ending before the middle of wing; third vein ending just at apex of wing; submarginal cell very broad; hind cross-vein at the middle of wing, just below the end of the second longitudinal vein; costal nick much developed ... ... 70. *Schistopterum*, Beck.

156 (155). Wings elongate, with parallel sides; second vein long and normal, ending beyond middle of wing; third vein ending before the tip of wing; submarginal cell of usual breadth; costal nick less developed.

157 (158). Prst. present; antennae not longer than the face; palpi not longer than the mouth; scutellum with two bristles only; discoidal cell short, the hind cross-vein being placed in the middle of wing, much before the end of the second longitudinal vein; fifth and sixth longitudinal veins reaching hind border of wing; body opaque black ... 71. *Brachiopterna*, Bezzi.

158 (157). Prst. wanting; antennae much longer than the face, with the third joint very elongate; palpi much longer than the mouth; scutellum with four bristles; discoidal cell long, the hind cross-vein being placed behind the middle of wing, just below the end of the second vein; fifth and sixth veins abbreviated, not reaching hind border; body and head shining black 72. *Bactropota*, gen. nov.

Subfam. I. DACINAE.

1. **Tridacus,** Bezzi, 1915.

It must be remarked that in my previous catalogue some species were placed in the present genus that do not belong there, like *furcatus*; some others are doubtful, like *scaber* and *flavicrus*, and one (*nebulosus*) was described from an unknown locality. There are in South Africa species of *Dacus* (*s. str.*) that are nearly as robust as, and have as broadly patterned wings as the true *Tridacus*.

The species known to me are as follows:—

1 (18). Wings with the brown costal border extended to the middle of the first posterior cell, or even to the fourth vein, or sometimes with a broad apical brown spot exceeding the fourth vein.

2 (5). Species of greater size (10-12 mm. in length), with no yellow humeral spot and with a very narrow yellow mesopleural stripe ; wings with a broad rounded apical brown spot, filling almost the whole of the first posterior cell and extending to the upper part of the second posterior cell.

3 (4). Yellow spot on hypopleura well developed and rather broad ; thorax with three yellow postsutural stripes ; scutellum darkened above *lounsburyi*, Coq.

4 (3). No distinct hypopleural spot ; thorax without yellow stripes ; scutellum entirely yellow ... ... *sphaeristicus*, Speis.

5 (2). Species of smaller size (8-9 mm.), with a distinct humeral spot and with a very broad mesopleural stripe ; wings without an apical spot, but with the brown fore border extended to the fourth vein, or to the middle of the first posterior cell ; if rarely there is a broad rounded terminal brown spot, this does not reach the second posterior cell, or only just.

6 (13). Two yellow hypopleural spots ; facial black spots always separated.

7 (10). Humeral calli entirely yellow ; yellow postsutural thoracic stripes broad ; facial black spots elongate.

8 (9). A broad rounded apical brown spot extending a little into the second posterior cell ; ovipositor short ... ... *fuscovittatus*, Grah.

9 (8). Wings with no such spot, with a broad apical border which does not reach the fourth vein ; ovipositor long ... ... *armatus*, F.

10 (7). Humeral calli brown, with only a small yellow spot at the fore corner ; thoracic postsutural yellow stripes narrow and less developed ; facial black spots rounded ; ovipositor short.

11 (12). Brown fore border extended to the middle of the first posterior cell or only a little below ... ... *bivittatus*, Big.

12 (11). Brown fore border reaching the fourth vein ... *pectoralis*, Walk.

13 (6). Only one hypopleural spot.

14 (15). Humeral calli brown, with a small yellow spot at fore corner ; facial black spots broadly separated ; wings with yellowish fore border, but with a broad rounded apical brown spot which ends at fourth vein *chrysomphalus*, Bezzi.

15 (14). Humeral calli entirely yellow ; facial black spots dilated and often united, the face becoming thus entirely black ; wings with a brown fore border and without such a terminal spot.

16 (17). Brown fore border of wing not reaching the fourth vein, but there is a brown stripe along this vein ; three postsutural yellow stripes on thorax *momordicae*, Bezzi.

17 (16). Brown fore border extending without interruptions to the fourth vein ; only two postsutural yellow stripes, the middle one wanting *eburneus*, Bezzi.

18 (1). Wings with the brown fore border narrower, not extending beyond the third longitudinal vein, or doing so only at the apex, and sometimes without any dark border at all and only with a small brown apical spot.

19 (24). No humeral and no hypopleural yellow spots ; mesopleural stripe narrow or indistinct.

20 (23). Wings with a brown anal stripe.

21 (22). Scp. thin and rudimentary ; scutellum entirely brown ; face unspotted ; wings broadly yellow towards the middle, with a blackish spot at the end of third vein and a brown stripe along the anal vein *xanthopterus*, Bezzi.

22 (21). Scp. well developed ; scutellum with only the basal half brown ; face with two black spots ; wings not so coloured ... ... *eclipsis*, sp. n.

23 (20). Wings without anal stripe ; face unspotted ; thorax and abdomen black above ; wings with the anterior cross-vein infuscated and with a brown apical spot ... ... *scaber*, Loew.
24 (19). Humeral and hypopleural yellow spots present.
25 (32). Only a single hypopleural spot.
26 (29). Wings without anal brown stripe ; an isolated brown spot at end of third vein ; face unspotted.
27 (28). Frons without black lateral spots ; a broad yellow mesopleural patch, reaching the humeral spot.
a (*b*). Thorax and abdomen with black markings ; black terminal spot of wing triangular ; ovipositor long ... ... *stylifer*, Bezzi.
b (*a*). Thorax and abdomen entirely reddish ; black spot of wing broad and quite round ; ovipositor short ... ... *sphaerostigma*, Bezzi.
28 (27). Frons with black lateral spots ; a narrow yellow mesopleural stripe ; ovipositor short ... ... *lotus*, Bezzi.
29 (26). Wings with an anal brown stripe ; face black-spotted.
30 (31). Dark reddish species, with light-coloured legs ; wings with the anterior cross-vein not infuscated ; scutellum yellow ; humeri with spot at front corner ... ... *humeralis*, Bezzi.
31 (30). Black species with black legs ; wings with infuscated cross-vein and blackish terminal spot ; scutellum black with yellow border and underside ; humeri with spot at hind corner ... ... *telfaireae*, sp. n.
32 (25). Two yellow hypopleural spots.
33 (36). Hypopleural spots separated, the upper one being smaller than the lower.
34 (35). Facial black spots small ; anterior femora with the apical half brown ; fuscous fore border of the wing in the middle extended to the third vein *disjunctus*, Bezzi.
35 (34). Facial black spots broad ; anterior femora entirely yellow ; fore border narrower, not exceeding the second vein in the middle ; abdomen with black median stripe ... ... *flavicrus*, Grah.
36 (33). Hypopleural spots contiguous and of equal size.
37 (38). A broad fuscous patch in the middle of wing, around the small cross-vein ; facial black spots small ; frons almost unspotted *d'emmerezi*, Bezzi.
38 (37). Wings without such a patch in the middle ; facial spots broad ; frons black-spotted ... ... *punctatifrons*, Karsch.

1. Tridacus chrysomphalus, Bezzi, Ann. S. Afr. Mus. xix, p. 453, 1924.

A South African species, which has also been found in Abyssinia.

2. Tridacus momordicae, Bezzi, 1915.

A female specimen from Obuasi, Ashanti, 27 iv. 1907 (*Dr. W. M. Graham*), differing from the type in having a well spotted and banded frons, and in the want of the dark stripe just above the last portion of the fourth longitudinal vein.

3. Tridacus eclipsis, sp. nov.

Very like *Dacus fuscatus*, Wied., but distinct in having a well developed a. sa. and a much more reduced wing pattern.

♀. Length of body, 9 mm. ; of wing, 8 mm.

Prevailing colour of body, dark reddish, with less developed yellow markings on thorax. Head of a yellowish colour ; occiput reddish, with a narrow but complete yellow border ; frons about twice as long as broad, opaque, with a narrow vertical transverse band, a very small black ocellar dot on a broad reddish spot, three brown spots on each side and a broad reddish spot in the middle ; lunula reddish, with a

fourth brown spot on each side. Face only a little shining; the two black spots are broad, transverse, placed towards the middle of the antennal grooves, with the internal corner prolonged into a black downward stripe which reaches the reddish mouth-border; parafacialia and peristomialia pale yellowish, the latter with a dark reddish spot. Antennae reddish, with the first joint shorter than the second, and the third twice as long as the second, darkened below and on the apical part; arista as long as the last two antennal joints, with yellowish base. Palpi and proboscis yellowish. All the cephalic bristles dark reddish; only two i. or. Thorax quite devoid of blackish markings, clothed on back of mesonotum with a short yellowish pubescence; humeral calli entirely reddish; three narrow yellow postsutural stripes and two complete brownish dorsocentral lines; pleurae with a narrow yellow mesopleural stripe, continued above on the sutural callosity and below with a small spot on sternopleura; hypopleura reddish without any yellow spot but clothed with white shining dust, like the posterior part of mesopleura and the sternopleura, which is, moreover, white-haired below. Scutellum yellow, but with the basal half dark reddish, as in *fuscatus*. Postscutellum and mesophragma entirely reddish, clothed with a faint whitish dust. All the bristles are dark reddish; middle scp. as strong as the lateral ones. Halteres pale yellowish. Abdomen rounded, narrowed at base, coloured and punctate like the back of mesonotum, and devoid of dark or pale markings; the short yellowish pubescence is more developed on the hind half; the sutures of segments are distinct; sides with whitish hairs which are longer at base; the oval smooth patches of last segment are of larger size. Venter dark reddish. Ovipositor reddish, short, its basal part being as broad as and not longer than the last abdominal segment. Legs entirely reddish, unspotted, with the base of femora yellowish (very narrowly on the two anterior pairs), and with the basal joints of all the tarsi whitish; pubescence whitish; spur of middle tibiae black; claws black, with reddish base. Wings greyish-hyaline, iridescent, with yellowish veins. The first four segments of the costa are all of about the same length; second longitudinal vein short, the fifth segment of costa being thus longer than the fourth; last portion of the fourth vein bisinuous; the prolongation of the anal cell is as long as the rest of the same cell and longer than the sixth vein. Stigma dark yellowish; there is a narrow fuscous border, not broader than the marginal cell and a little dilated at end of third vein, but not spot-like; submarginal cell slightly yellowish; a faint pale yellowish patch at the small cross-vein; anal dark stripe broad, but ending before reaching hind border of wing. The base of the first basal cell is yellowish above the second basal cell, as is usually the case.

Type ♀, a single specimen from Durban, Botanical Gardens, 8 vii. 1902 (*F. Muir*).

4. Tridacus sphaerostigma, Bezzi, Ann. S. Afr. Mus. xiv, p. 457, 1924.

A recently described species from South Africa.

5. Tridacus lotus, Bezzi, Ann. S. Afr. Mus. xix, p. 455, 1924.

A South African species recently described.

6. Tridacus telfaireae, sp. nov.

A black, elongate species, easily distinguishable by the coloration of the scutellum, legs and wings.

♂ ♀. Length of body 6–6·5 mm.; of wing 5–5·5 mm.

Prevailing colour of body and legs black, with thin whitish pubescence and narrow yellow markings. Head dark reddish-yellow; occiput shining black, with a very narrow yellow border at eyes and a small yellowish postvertical spot. Frons proportionally narrow, reddish brown, rather shining at the sides and behind, with narrow yellowish border on apical half; no distinct lateral spots; lunula shining reddish.

Face shining reddish-yellow, with indistinct black spots, which are sometimes hardly visible; parafacialia and peristomialia reddish, the subocular spot indistinct. Antennae with the second joint longer than the first, and the third two and a half times as long as the second; the two basal joints are yellowish, while the third is wholly blackish; arista with a black base. Palpi and proboscis dark yellowish Cephalic bristles black; only two i. or. Thorax with dark reddish humeri, which bear a yellow spot at hind corner; anteriorly the thorax is sometimes narrowly dark reddish, being quite black elsewhere, even on the pleurae; on the back there are three indistinct narrow darker stripes, and just behind the suture there is sometimes a short narrow yellow median stripe. Mesopleural whitish stripe moderately broad, continued with the usual sternopleural and sutural spots; the single whitish hypopleural spot is normal; sternopleura below with a few white hairs. Scutellum black above, yellow below, with a yellow border; postcutellum and mesophragma entirely black. All the bristles black; a. sa. strong. Halteres pale yellowish. Abdomen like back of mesonotum, without pale markings, except a faintly indicated pale yellowish hind border at sides of the second segment; sides with whitish hairs; third segment of male with long black cilia. Venter black. Male genitalia black; ovipositor black, its basal part not longer than the last abdominal segment, which has the smooth oval patches less marked. All the legs and coxae black; femora with the base yellowish, more broadly so on the hind pair; all the praetarsi whitish; claws black, pulvilli yellowish. Wings hyaline, with black veins; last portion of fourth vein sinuous at base, but straight at end. Prolongation of anal cell longer than (♂) or as long as (♀) the rest of the anal vein. Lower end of small cross-vein placed distinctly beyond middle of discoidal cell. Wing-pattern much reduced; a faintly marked darkish narrow border along the costa, and a small blackish rounded spot at end of third vein, appearing rather isolated. Small cross-vein distinctly and rather broadly infuscated. Anal stripe broad; in the male it is prolonged to the hind border, being there below in contact with the faint fuscous spot of the external corner of the axillary cell; in the female it is acute at the end and does not reach the hind border. First basal cell with the usual infuscation at upper border of the dilated second basal cell.

Type ♂, type ♀, and some additional specimens from Tanganyika Territory, Amani, xi. 1921, reared from *Telfairea pedata* (*A. H. Ritchie*).

2. **Dacus,** Fabricius, *s.str.*

The numerous species of the present genus are not easy to recognise from descriptions; the following key is thus not quite satisfactory. Some species of *Tridacus* have been repeated here, because it is not certain whether they belong to *Dacus* or to *Tridacus*.

1 (10). Species of greater size (7–9 mm. in length) with the brown fore border of wings, or with the broad terminal spot, extending into the first, or even into the second posterior cell; yellow mesopleural stripe very narrow.

a (*b*). Antennae very elongate, with the first joint about as long as the second ... *lounsburyi*, Coq.

b (*a*). Antennae not so elongate, with the first joint much shorter than the second.

2 (5). No humeral and no hypopleural yellow spots; third abdominal segment of male ciliated.

3 (4). Scutellum entirely reddish brown, with a yellow hind border; discoidal cell infuscated ... ... *fuscatus*, Wied.

4 (3). Scutellum entirely yellow, with a narrow reddish hind border; discoidal cell quite hyaline ... ... *aspilus*, Bezzi.

5 (2). Two well-developed yellow hypopleural spots.

6 (9). Wings with a distinct anal dark stripe and without a broad rounded terminal spot; last joints of tarsi blackened; third abdominal segment of male ciliated.
7 (8). Humeri reddish, at most with a small yellow spot; scutellum broadly reddish brown above; brown costal border extended to the fourth longitudinal vein ... ... *subfuscatus*, Bezzi.
8 (7). Humeri and scutellum entirely yellow; brown costal border not reaching fourth vein ... ... *brevistriga*, Walk.
9 (6). Wings without anal stripe, but with a very broad rounded fuscous spot at end, extending into the second posterior cell; humeral calli reddish; tarsi entirely yellow; third abdominal segment of male not ciliated *marshalli*, sp. nov.
10 (1). Species of smaller size (4–6 mm.) with narrower brown costal border, or even without any dark costal border at all; rarely there is a dark patch across the middle of the wing.
11 (32). Wings with distinct anal brown stripe; face black-spotted; third abdominal segment of male ciliated.
12 (15). No distinct yellow hypopleural spots and no yellow mesopleural stripe.
13 (14). Small cross-vein infuscated ... ... *semisphaereus*, Beck.
14 (13). Small cross-vein not infuscated ... ... *bistrigatus*, Loew.
15 (12). Yellow hypopleural and mesopleural markings well developed.
16 (23). A single hypopleural spot.
17 (18). Facial black spots in the shape of a narrow stripe *bistrigulatus*, Bezzi.
18 (17). Facial black spots rounded as usual.
19 (20). Scutellum reddish brown, with a yellow spot on each side; prsc. present; wings without dark fore border and without dark apical spot *Chaetodacus biguttulus*, Bezzi.
20 (19). Scutellum entirely yellow; prsc. wanting; wings with fore border and with apical spot.
21 (22). No fuscous spot below the end of fifth longitudinal vein *brevistylus*, Bezzi.
22 (21). A fuscous spot below end of the above-named vein in the male *ciliatus*, Loew.
23 (16). Two contiguous yellow hypopleural spots.
24 (29). Terminal portions of third and fourth veins distinctly sinuous.
25 (28). Apical dark spot of the wing united with the brown costal border; species of smaller size.
26 (27). Front with a blackish central spot and three dark orbital spots on each side *vertebratus*, Bezzi.
27 (26). Orbital spots not distinct ... ... *frontalis*, Beck.
28 (25). Apical dark spot isolated from the yellowish costal border; greater size *marginalis*, Bezzi.
29 (24). Tips of third and fourth veins nearly straight.
30 (31). Apical spot united with the dark fore border; greater size *africanus*, Adams.
31 (30). Apical spot isolated; smaller size ... ... *ficicola*, Bezzi.
32 (11). No distinct anal brown stripe on the wings.
33 (56). Face entirely yellow, devoid of black spots.
34 (35). No distinct yellow hypopleural spots ... ... *scaber*, Loew.
35 (34). Hypopleural spots well developed.
36 (51). Only a single hypopleural spot; mesopleural stripe very broad; front narrow; third abdominal segment of male not ciliated.
37 (38). Humeral cells reddish brown; a broad whitish pollinose median stripe on the back of mesonotum; fuscous apical border of wing extended to the fourth vein ... ... *katonae*, sp. nov.
38 (37). Humeral cell entirely yellow.

39 (46). Submarginal cell entirely hyaline or only slightly infuscated at the extreme base; legs pale yellowish.
40 (45). Small cross-vein not infuscated.
41 (42). Frons with black orbital spots; abdomen black in the middle, with a reddish band at hind border of second segment *annulatus*, Beck.
42 (41). Frons not so spotted; abdomen red along the middle.
a (*b*). Scutellum entirely red, like thorax and abdomen ... *rubicundus*, Bezzi.
b (*a*). Scutellum yellow; abdomen broadly black at sides.
43 (44). Thorax mainly black; submarginal cell quite hyaline at base *hyalobasis*, sp. nov.
44 (43). Thorax mainly reddish; submarginal cell slightly infuscated at base *xanthopus*, Bezzi.
45 (40). Small cross-vein infuscated; abdomen entirely black, with reddish tip; frons unspotted ... ... *maynei*, Bezzi.
46 (39). Submarginal cell broadly infuscated at base, or even sometimes entirely black.
47 (50). Submarginal cell infuscated at base only; abdomen red in parts.
48 (49). Small cross-vein infuscated above; thorax black; median reddish stripe abdomen divided by a black longitudinal line ... *mochii*, Bezzi.
49 (48). Small cross-vein not infuscated; thorax reddish, no black longitudinal line in the reddish abdominal stripe ... ... *woodi*, Bezzi.
50 (47). Submarginal cell entirely infuscated throughout its whole length; abdomen entirely black ... ... *macer*, Bezzi.
51 (36). Two contiguous hypopleural spots; mesopleural stripe narrower; legs partly infuscated.
52 (53). Apical spot of the wing united with the narrow fuscous fore borders; no fuscous spot at end of sixth vein in the male; third abdominal segment of male not ciliated; frons purplish, face white ... *purpurifrons*, Bezzi.
53 (52). Apical dark spot isolated; fuscous spot at end of anal vein well developed; third segment ciliated.
54 (55). Thorax and abdomen entirely black; legs partly brown *binotatus*, Loew.
55 (54). Thorax and abdomen entirely reddish; legs more yellowish *immaculatus*, Coq.
56 (33). Face with the usual black spots, or even entirely black.
a (*b*). Thorax and scutellum entirely reddish, without any yellow markings *apoxanthus*, Bezzi.
b (*a*). Thorax and scutellum with distinct yellow markings; hypopleural spots always present.
57 (80). Only a single hypopleural spot.
58 (63). Face entirely black; wings destitute of apical dark spot; frons black; back of mesonotum with a yellow spot or stripe in front of the scutellum.
59 (60). Humeral celli quite yellow; wings destitute of fuscous band in the middle, quite hyaline, with blackish stigma and slightly infuscated small cross-vein *inornatus*, Bezzi.
60 (59). Humeral calli shining black, with a yellow spot at hind corner; wings with a broad fuscous band in the middle.
61 (62). Wings with the small cross-vein placed in middle of discoidal cell, and with a fuscous arched band across the middle of that cell, abdomen carinate above ... ... *hamatus*, Bezzi.
62 (61). Wings with the small cross-vein considerably beyond middle of discoidal cell, and with a broad, fuscous triangular patch at end of the cell; abdomen not carinate ... ... *trigonus*, Bezzi.
63 (58). Face yellow, with the two usual black spots.
64 (65). Wings quite unadorned, with yellowish stigma and without apical spot *elutissimus*, sp. nov.

65 (64). Wings with at least the apical spot distinct, and sometimes with a narrow dark costal border.
66 (71). Wings with a colourless or pale yellowish stigma, and with a faintly infuscated apical spot at end of third vein.
67 (68). Scutellum entirely yellow; back of mesonotum with three distinct darkish longitudinal stripes; male with the third abdominal segment ciliated, and with a rather distinct supernumerary anal lobe on the wings *oleae*, Gmel.
68 (67). Scutellum black or reddish brown in the middle; back not so striped; third segment not ciliated and anal lobe not distinct.
69 (70). Scutellum yellow, with a broad black stripe in the middle; thorax and legs in part black ... ... *mesomelas*, Bezzi.
70 (69). Scutellum reddish brown, with a rounded yellow spot on each side; thorax and legs entirely reddish ... ... *bigemmatus*, Bezzi.
71 (66). Wings with blackish stigma, and with a more intensively infuscated terminal spot, or with a narrow blackish costal border.
72 (77). Apical spot isolated.
73 (76). Last segment of fourth vein straight at end.
74 (75). Thorax and abdomen prevalently black; scutellum broadly black at base; legs in part black; third abdominal segment of male not ciliated *erythraeus*, Bezzi.
75 (74). Thorax and abdomen reddish at sides; scutellum narrowly black at base; legs entirely yellowish; third segment ciliated ... *brevis*, Coq.
76 (73). Last segment of fourth vein deeply bisinuous ... ... *sigmoides*, Coq.
77 (72). Apical spot united with the brown costal border; last portion of fourth vein straight; four posterior tibiae blackish; third abdominal segment of male ciliated.
78 (79). Prevalently black species ... ... *blepharogaster*, Bezzi.
79 (78). Prevalently reddish species ... ... *rufus*, Bezzi.
80 (57). Two yellow hypopleural spots.
81 (82). Body short as usual; abdomen rounded; pterostigma blackish *ficicola*, Bezzi.*
82 (81). Body slender and elongate; abdomen cylindrical; pterostigma pale yellowish.
83 (84). Back of mesonotum without yellow median spot behind the suture *sexmaculatus*, Walk.
84 (83). A yellow postsutural spot in front of the scutellum ... *longistylus*, Wied.

1. Dacus aspilus, Bezzi, Rev. Zool. Afr. xii., p. 10, 1924.

A recently described species from the Congo.

2. Dacus subfuscatus, Bezzi, Ann. S. Afr. Mus. xix, p. 460, 1924.

A South African form of *fuscatus*, recently described.

3. Dacus brevistriga, Walker, 1861.

A comparatively large species, very like a *Tridacus* of the group *bivittatus*, but but without a. sa.; it is distinguished from *fuscatus*, if my interpretation is correct, by some details of coloration.

A female specimen from Natal, Pinetown, 3 vi. 1902 (*F. Muir*).

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*This species is repeated here because the dark anal stripe of the wings is sometimes hardly visible.

4. Dacus marshalli, sp. nov.

A very distinct species, nearly resembling a *Tridacus* of the first group, but at once distinguishable, apart from the generic character, by the lack of the fuscous anal stripe of the wings.

♂♀. Length of body 7–8 mm.; of wing 6–7 mm.

Head entirely reddish. Occiput opaque, whitish-dusted, with a dark spot above the neck, and with a narrow yellowish border at eyes. Frons broad and short, only 1½ times longer than broad, clothed with whitish dust and thus, when viewed from in front, appearing white, chiefly in the male; the sides are slightly yellowish, with no very distinct dark dots; lunula shining reddish; only two i. or. Face shining reddish-brown and thus contrasting strongly with the opaque white frons; the two black spots are broad and rounded, placed near the mouth-border, but not very conspicuous because of the dark colour of the face. Antennae entirely reddish; second joint elongate, more than twice as long as the first; third joint proportionately short, only twice as long as the second; arista reddish. Peristomialia with the dark subocular spot indistinct. Palpi and proboscis reddish, the latter with yellowish hairs. Bristles black. Thorax entirely dull reddish, finely punctate, with short yellowish pubescence on the back. Humeral calli entirely reddish; behind the suture there is a continuous narrow yellow middle line, not always visible, like the darker patches before the scutellum. Pleurae reddish, with a very narrow yellow mesopleural stripe, which is bordered with blackish anteriorly, prolonged above along the suture to the middle of the back, and continued below with a small spot on sternopleura; this last is blackish below, white-dusted and with white hairs on the breast. There are two more or less broad and contiguous hypopleural spots, margined with black below. Scutellum yellow, with the basal half reddish brown. Mesophragma blackish, with a narrow reddish middle stripe. Halteres yellowish; calypters white and with a white fringe. Abdomen convex, rather elongate, with rather long whitish pubescence; it is reddish, with more or less broad black rounded spots at sides of third to fifth segments, broader in the female; moreover, the second and the last segment are more or less distinctly yellowish at hind border; third segment of male not ciliated; the sutures are not distinguishable in the middle; the oval patches of the last segment are not much developed. Venter reddish like the male genitalia; ovipositor dark reddish, with black base, strong, conical, about 3 mm. in length, but the prominent part is only one-half as long. Legs yellowish, the terminal part of femora and the most of the tibiae dark reddish; tarsi entirely yellowish, with the terminal joints not at all infuscated; pubescence white; spur black; claws black with reddish base. Wings hyaline, with yellowish veins and yellowish stigma. Last portion of fourth vein slightly sinuous and parallel with the last portion of the third, small cross-vein a little beyond middle of discoidal cell; the lobe of the anal cell in the male longer, in the female as long as the last portion of the anal vein. The fuscous pattern is formed by a very broad, rounded patch which extends over the whole apical part of wing beyond the small cross-vein, reaching below the fifth longitudinal vein and filling up the terminal half of the discordal cell; in the female this patch is narrower, being more distant from the apical and posterior wing-border. There is no trace of an anal stripe, and even the usual dark spot just above the second basal cell is hardly visible; the infuscation below the end of sixth vein in the male is likewise indistinct.

Type ♂, type ♀, and some additional specimens of both sexes from Southern Rhodesia, Chirinda Forest, x. 1905, collected by Dr. G. A. K. Marshall, in whose honour this fine insect is named.

5. Dacus brevistylus, Bezzi, 1908.

A female specimen from Gold Coast, Aburi, 11 iv. 1911 (*L. Armstrong*).

This widely distributed species may perhaps be found to be the same as *ciliatus*, owing to the fact that the fuscous spot at end of the fifth vein may be the usual spot at end of sixth vein.

6. **Dacus frontalis,** Becker, 1922, Denkschr. Akad. Wiss. Wien. Math.–Naturwiss. Kl., xcviii., p. 74.

This species was recently described from the British Sudan.

7. **Dacus katonae,** sp. nov.

This East African species will be more fully described elsewhere.

8. **Dacus rubicundus,** Bezzi, Ann. S. Afr. Mus. xix, p. 463, 1924.

A recently described South African species.

9. **Dacus hyalobasis,** sp. nov.

The same remark applies to this East African species.

10. **Dacus xanthopus,** Bezzi, Ann. S. Afr. Mus. xix, p. 464, 1924.

A South African representative of *D. woodi*, Bezzi.

11. **Dacus maynei,** Bezzi, Rev. Zool. Afr. xii, p. 11, 1924.

A recently described species from the Congo.

12. **Dacus purpurifrons,** Bezzi, Ann. S. Afr. xix, p. 464, 1924.

A recently described South African species.

13. **Dacus apoxanthus,** Bezzi, Ann. S. Afr. Mus. xix, p. 466, 1924.

A recently described species from South Africa.

14. **Dacus elutissimus,** sp. nov.

A pale reddish, white-spotted species, which is distinguished from all the others at present known by its wings being destitute of any pattern.

♂ Length of body 5 mm. ; of wing 4 mm.

Head entirely reddish ; occiput rather shining, unspotted, with an indistinct paler border at eyes. Frons about twice as long as broad, quite unspotted, even the ocellar dot being reddish ; it is opaque, with shining sides, and has only two i. or. ; lunula shining reddish. Face whitish, shining, with two rounded black spots below the middle ; no subocular spot. Antennae entirely pale reddish, with the third joint three times as long as the second ; palpi and proboscis pale yellowish ; bristles black. Thorax entirely reddish, punctulate, without any dark markings ; a broad, whitish tomentose stripe along middle of back ; humeri whitish ; pleurae rather shining, with a broad, whitish mesopleural stripe, prolonged above along the suture as a broad triangular spot, and below with a small spot at upper border of sternopleura ; a single whitish, rounded hypopleural spot. Scutellum entirely whitish. Mesophragma reddish ; bristles black. Halteres whitish. Abdomen elongate, entirely pale reddish and unspotted, but the second segment with a paler lined border ; the whitish pubescence is larger than that of thorax ; third segment ciliated ; oval shining patches of last segment not conspicuous ; venter and genitalia reddish. Legs entirely pale yellowish, even the whitish tarsi not infuscated at end ; spur of middle tibiae black. Wings hyaline, quite unspotted, with only a pale yellowish stigma and a very faint infuscation at end of submarginal cell, but not in the shape of a terminal spot, being not visible

below third vein. The terminal portions of third and fourth veins are rather straight and parallel; small cross-vein a little beyond middle of discoidal cell. All the veins pale yellowish.

Type ♂, a single specimen from West Africa, Lome in Togo, about 80 miles west of Cotonou, 12 i. 1914 (*Dr. W. A. Lamborn*).

15. Dacus bigemmatus, Bezzi, Ann. S. Afr. Mus. xix, p. 476, 1924.

A recently described South African species.

3. Afrodacus, Bezzi, 1924.

Of this genus a South African species was recently described by me under the name of *Chaetodacus biguttulus* (Boll. Lab. Zool. Portici, xv, 1922, p. 294). In the presence of the prsc. and of the sexual wing-dimorphism it is a true *Chaetodacus*, but it differs in lacking the a. sa. (Ann. S. Afr. Mus. xix, p. 469, 1924).

Subfam. II. ADRAMINAE.

4. Meracanthomyia, Hendel, 1910.

Only one Ethiopian species known, *M. antennata*, Hendel, 1912, from W. Africa.

5. Munromyia, Bezzi, 1922.

Only one South African species, the recently described *M. nudiseta*, Bezzi (Boll. Lab. Zool. Portici, xv, 1922, p. 299).

6. Sosiopsila, Bezzi, 1920.

But a single African species, *S. trisetosa*, Bezzi, 1920, from Portuguese East Africa and Nyasaland.

Subfam. III. CERATITINAE.

The three following genera must be considered as a connecting link between the present and the preceding subfamily, and are placed at beginning of the CERATITINAE because they have a few ocp., the hm., and a few bristles on the underside of the front femora.

7. Trypanophion, gen. nov.

This new genus is erected for a very striking large species, which seems to be allied to the recently described *Xaniosternum ophioneum*, End., but is at once distinguishable by the want of the dc. and by the uncompressed abdomen. The genus agrees in some points with the ADRAMINAE, but it is distinguished by the presence of the hm., and by the presence of some ocp.; it is nearly allied to *Coelopacidia*.

Head a little broader than the thorax, in front view broader than high; occiput convex, with much developed lower swellings. Frons broad, concave, about as long as broad; in profile it is prominent only in front, forming an elongate protuberance on which are inserted the antennae; the ocelli are closely approximated and very near to the vertex. Face retreating, concave in the middle, with shallow antennal grooves and rather prominent at mouth-border. Lunula very small and concealed. Antennae inserted above the middle of eyes, rather porrect on account of the frontal prominence, but proportionately short and obviously shorter than the face; first joint very short; second joint elongate, setulose but not spinulose above; third joint only a little longer than the second, gradually attenuated but obtuse at end; arista basal, very shortly pilose. Eyes bare, rounded, with equal areolets, with the vertical diameter one and a half times as long as the transverse one. Mouth-

opening broad; proboscis short; palpi not much dilated. Parafacialia linear; peristomialia a little narrower than the breadth of third antennal joint. Ocp. reduced to two black bristles on each side at upper part; outer vt. not much smaller than the rather short interior ones; pvt. small; the s. or. is in the middle of frons, the vertical plates being very broad and reaching the middle of frons; two i. or.; genal bristle rather thin. Thorax elongate, with parallel sides, twice as long as broad, with complete transverse suture, flattened above; posterior part much developed, the mesophragma being less oblique. Scutellum proportionately small, one fourth as long as the thorax, triangular flat above. Chaetotaxy reduced; scp. developed, the inner very close together, the outer very strong; one hm., two npl., one a. and two p. sa.; only the a. sct. present; dc., prst. and prsc. wanting, like all the pleural bristles; sternopleura below, just in front of the middle coxae, with a single row of bristles. Abdomen elongate, much narrower than and twice as long as the thorax; it is cylindrical, not compressed, but distinctly curved; there are four visible segments in the male and five in the female; first segment bristly at sides at base, last segment bristly at hind border. Male genitalia not prominent; ovipositor strong, cylindro-conical, as long as the last two abdominal segments together. Legs slender and elongate; front femora with only one to two bristles at end below; middle femora not thickened, distinctly curved above at end, as long as the thin middle tibiae, which have two equal spurs at end; all the praetarsi densely ciliated below; hind tibiae shorter than their femora, with a row of bristles along the outer side; claws short. Wings long and broad, devoid of pattern. Costa without bristles, shortly pilose; auxiliary vein close to the first vein and ending at a right angle; first vein ciliated, ending a little before the small cross-vein; second and third veins straight, the latter bristly to just beyond the small cross-vein, which is placed a little beyond the middle of the very long discoidal cell; hind cross-vein straight and perpendicular; anal cell drawn out into a point, which is shorter than the undilated second basal cell; sixth vein reaching the hind border; axillary lobe equal in the two sexes; alula longer than broad.

Type: the following new species.

1. Trypanophion gigas, sp. nov.

A striking fly of large size, not unlike certain Hymenopterous insects of the Ichneumonidae.

♂ ♀. Length of body 13–13·5 mm.; of wing 10·5–11 mm.; of ovipositor 2 mm.

Occiput shining black, with a broad white lateral border, which is wanting on the upper part near vertex and is narrowed in the middle. Frons likewise shining black, but the very broad vertical plates and a narrow border near the eyes are whitish yellow, like the very small and hardly visible lunula. Antennae entirely black. Face shining whitish yellow, with a triangular black spot in the middle, which is placed with the base at mouth-border and the vertex at root of antennae. Parafacialia and peristomialia whitish yellow, the latter without any subocular spot. Palpi and proboscis reddish, the former with black tip. All the bristles black. Thorax on the back shining reddish, punctulate, with short, yellowish or darkish pubescence; along the middle line there is a yellowish white stripe, which begins narrowly just behind the middle scp. and continues, gradually widening, to the scuellum, without being interrupted at the suture; in its terminal broader part it is margined with a black line on each side. Humeral calli prominent, entirely yellow, margined with black; a black notopleural stripe to the suture. Pleurae shining black above, reddish below, with a whitish stripe from humeri to the root of wings on the whole hind border of mesopleura; sternopleura black above and reddish below; a broad, oval, hypopleural whitish spot; mesophragma reddish, with blackish sides. Scutellum reddish, with a whitish, black-margined stripe continuous with that of the back; all the bristles black. Halteres whitish. Abdomen entirely shining

reddish, unspotted ; pubescence yellowish, bristles black ; male genitalia reddish, with a long appendage below ; ovipositor shining reddish, with the apex black and with dark hairs. Venter entirely reddish. The four anterior coxae are whitish, those of the hind pair reddish brown ; legs entirely reddish, the tarsi blackened at end ; bristles, spurs and hairs black. Wings with an even faint yellowish tinge, very shining but less iridescent ; veins blackish, last portions of third and fourth slightly diverging at end. Stigma deep black. Hind cross-vein faintly and narrowly infuscated below, like the last portion of fifth vein ; second and third longitudinal veins with a faint narrow infuscation at end, along the costa.

Type ♂ and type ♀, Uganda, Entebbe, 10. ii. 1913, and Kampala, 16. ix. 1918 (*C. C. Gowdey*).

8. **Coelopacidia,** Enderlein, 1911.

Nothing is to be added to my key of 1920, p. 218, of the three known species.

1. Coelopacidia strigata, Bezzi. 1920.

One female specimen from Southern Rhodesia, Chirinda Forest, x. 1905 (*G. A. K. Marshall*).

9. **Stenotrypeta,** Enderlein, 1920.

This recently described genus (Zool. Jahrb. xliii, Abt. f. Syst., p. 338) is possibly the same as the preceding one, as interpreted by me for the two species *strigata* and *melanostigma* ; and the name must be used for them, if they prove to be not congeneric with the type species *madagascariensis*, which is still unknown to me. Enderlein has described two species, *S. torrida* from Lake Nyasa with unspotted wings, and *S. punctum* from Spanish Guinea with a fuscous apical spot on the wing. But the author speaks of the presence of dc. in these species, while in my two species the dc. are wanting.

10. **Xaniosternum,** Enderlein, 1920.

Only one species known, *X. ophioneum*, End. (Zool. Jahrb. xliii, Abt. f. Syst., p. 336), from Spanish Guinea.

11. **Conradtina,** Enderlein, 1911.

The known species, mostly distinguished on weak characters of wing-pattern, are as follows :—

1 (2). Apical fuscous band contiguous with the costa, and thus filling up entirely the wing tip ; on the middle of last portion of fourth vein there is an oblique fuscous streak, united with the apical border ; the two fuscous bands connected below ... ... *longicornis*, End.

2 (1). Apex of wing at end of third and fourth longitudinal veins more or less broadly whitish-hyaline, the apical fuscous band being therefore not contiguous with the wing border.

3 (6). An oblique fuscous streak on the middle of last portion of fourth vein ; the two fuscous bands in the middle of wing are united below.

4 (5). Head mainly yellowish ... ... *limbatella*, End.

5 (4). Head mainly black ... ... *acrodiauges*, Speis.

6 (3). No oblique fuscous streak on last portion of fourth vein.

7 (12). The two fuscous bands on the middle of wing are quite separated at hind border.

8 (9). The hyaline apical border is very narrow, like in all the preceding species *limbata*, End.

9 (8). Apical hyaline border rather broad.
10 (11). The apical fuscous band is entire ... ... *acroleuca*, Wied.
11 (10). This band is broadly interrupted in the middle ... *tristriata*, Karsch.
12 (7). The two bands unite to form a single broad fuscous patch which is united by a brown streak to the fore border ... ... *suspensa*, Bezzi.

1. Conradtina limbatella, Enderlein, Zool. Jahrb. xliii, Abt. f. Syst., p. 342, 1920.

Described from Cameroons ; is probably the same as *acrodiauges*, Speis.

2. Conradtina limbata, Enderlein, p. 343, 1920.

Likewise from Cameroons.

3. Conradtina tristriata, Karsch, 1887.

Previously placed by me in *Phorellia* with a query ; but Enderlein, who has seen the type, has located the species in the present genus. It is possibly the same as *acroleuca*, Wd.

12. Celidodacus, Hendel, 1924.

Enderlein in 1920 united the present genus with the preceding one, and stated (after examination of the type at Berlin) that *obnubila*, Karsch, belongs here, as already indicated by me ; it is even probable that it is the same as *apicalis*, Hendel.

The known species, which have all a uniform wing-pattern, can be distinguished as follows :—

1 (8). The two cross-veins comprised in the same fuscous patch, which fills up almost the whole terminal part of the wing.
2 (5). The fuscous band below the stigma is simple, filling up only the extreme base of submarginal cell ; inner margin of the broad terminal patch quite straight.
3 (4). No hyaline spot on the second longitudinal vein ; hyaline indentation of the second posterior cell short, not extending to the fourth vein *obnubilus*, Karsch.
4 (3). A hyaline spot on the second vein ; the above-named indentation is much broader and extends into the first posterior cell ... *ornatus*, var. nov.
5 (2). The above-named fuscous band is dilated inwardly, filling up broadly the base of submarginal cell, and unites there with a projection of the apical patch, including thus a well-defined hyaline subquadrate indentation of fore border.
6 (7). Base of first posterior cell not spotted ... ... *fenestratus*, End.
7 (6). Base of first posterior cell with a hyaline spot ... *oculatus*, Bezzi.
8 (1). A separated fuscous band, on the small cross-vein, extending from the fore to hind border of wing.
9 (10). The fuscous band on the small cross-vein is united with the terminal patch by a narrow fuscous border along the costa ; second posterior cell without hyaline indentation ... ... *conjunctus*, End.
10 (9). The above-named band quite separated ; second posterior cell with hyaline indentation ... ... *coloniarum*, Speis.

1. Celidodacus obnubilus, Karsch, 1887.

Several specimens of this common species from Nyasaland, Mt. Mlanje, 7. xi. 1913 (*S. A. Neave*) ; Cholo, 3,000 ft., ix. 1917 and xii. 1919 (*R. P. Wood*) ; South Nigeria, Okogwe, 27. xii. 1920. C.

2. Celidodacus ornatus, var. nov.

A variety of the preceding from East Africa, that will be more fully described elsewhere.

3. **Celidodacus fenestratus,** Enderlein, Zool. Jahrb. xliii, Abt. f. Syst., p. 343, 1920 (*Conradtina*).

A not rare West African species.

4. **Celidodacus oculatus** (Enderlein) Bezzi, Rev. Zool. Afr. xii, p. 13, 1924.

A variety of the preceding species from the Congo.

5. **Celidodacus conjunctus,** Enderlein, *l.c.*, p. 344, 1920 (*Conradtina*).

Described from Spanish Guinea.

13. **Carpophthoromyia,** Austen, 1910.

Even after eliminating some of the species originally included in it, the present genus is still rather a large one, four additional species having been recently described by Enderlein.

1 (22). Second longitudinal vein more or less straight ; base of wing wholly infuscated, without numerous hyaline streaks ; scutellum flat above, and white or pale yellowish in colour.

2 (11). Wing without hyaline indentations at fore border, and with the ʌ-shaped band united or wanting.

3 (8). Hind cross-vein S-shaped and very oblique outwardly ; frons and face broad ; second longitudinal vein straight ; scutellum yellow with brown tip ; humeral callosities yellow.

4 (5). No yellow hypopleural spots ; brown tip of scutellum narrow ; mesopleural yellow stripe oblique and broadened below ; femora blackish *vittata*, Fabr.

5 (4). Two yellow hypopleural spots.

6 (7). The brown tip of scutellum is narrower than the space between the a. sct. ; hyaline band of wing not interrupted at bend ; femora blackish *amoena*, End.

7 (6). Scutellum with the apical half brown ; hyaline band interrupted ; femora reddish ; antennae yellow ; metapleural yellow stripe horizontal and narrow ... ... *dimidiata*, Bezzi.

8 (3). Hind cross-vein straight and less oblique ; no yellow or white hypopleural spots.

9 (10). Frons and face broad ; second longitudinal vein straight ; scutellum whitish, unspotted ; antennae reddish ; humeri white, wings with a complete middle band, but with the cubital band quite wanting *woodi*, sp. nov.

10 (9). Frons and face unusually narrow ; second longitudinal vein a little wavy ; scutellum blackish, with a shining black hind border ; antennae black ; no white humeral spot ; the ʌ-shaped band present, even if not regular ... ... *angusticeps*, sp. n.

11 (2). Wings with hyaline indentations at fore border near the stigma ; ʌ-shaped band isolated ; hind cross-vein straight and less oblique.

12 (15). Scutellum quite white, unspotted ; costal cells in part hyaline.

13 (14). Femora tawny ; brown basal band of wing ending at apex of anal vein ; smaller size (5–6 mm. in length) ... ... *scutellata*, Walk.

14 (13). Femora blackish ; basal band ending beyond anal vein ; greater size (8–10 mm.) ... ... *procera*, End.

15 (12). Scutellum on its posterior margin with three black spots, which are not visible from above ; costal cells wholly infuscated.

16 (21). Wings without hyaline spots at base ; femora blackish.

17 (18). Humeral callosities dark brown ; frons with a transverse dark band ; whitish mesopleural strip vertical ... ... *tritea*, Walk.

18 (17). Humeral callosities yellowish ; mesopleural stripe horizontal.
19 (20). Frons with a brown longitudinal stripe ... *pseudotritea*, Bezzi.
20 (19). Frons entirely yellow, not striped ... ... *nigribasis*, End.
21 (16). Wings with some hyaline spots at base ; femora yellowish *tessmanni*, End.
22 (1). Second longitudinal vein distinctly wavy ; wings with numerous basal streaks ; scutellum rather convex and shining black abdomen with two broad bands of whitish pollen ... ... *superba*, Bezzi.

I think that *vittata* and *tritea* may be considered as being congeneric, notwithstanding the very different hind cross-vein ; under the name of *vittata* several different species have been confused, and it is difficult to say what is the true Fabrician form, as in the original description nothing is said about the colour of the antennae. The *tritea* of Enderlein (1920) is probably not that species, but *pseudotritea*.

1. Carpophthoromyia amoena, Enderlein, Zool. Jahrb. xliii, Abt. f. Syst., p. 356, 1920.

Described from Cameroons.

2. Carpophthoromyia dimidiata, Bezzi, Ann. S. Afr. Mus. xix, p. 474, 1924.

A recently described South African species, previously confused with *vittata*.

3. Carpophthoromyia woodi, sp. nov.

Placed in the present genus on account of the position of the hind cross-vein ; it is very different from all the other species in having a complete median band, and in lacking any trace of a cubital band or of infuscation of hind cross-vein.

♀. Length of body, 5 mm. ; of wing, 5·2 mm.

Occiput black in the middle above the neck, reddish at vertex and at margin of eyes, yellowish below on the rather developed but not very prominent lateral swellings. Frons reddish on the basal part, and there with shining orbital plates and with a small blackish ocellar dot, opaque yellowish elsewhere ; lunula small and hardly visible. Antennae dark reddish ; second joint not spinulose above ; third joint gradually attenuated, but without prominent point at upper corner, about as long as the face ; arista with very short and thin pubescence. Face with a reddish transverse band below the root of antennae, opaque whitish elsewhere ; mouth-border not prominent ; peristomialia about as broad as the third antennal joint, yellowish, with a reddish brown subocular spot ; the face is much broadened below. Palpi and proboscis reddish, the former with small black bristles, the latter thick and short. All the cephalic bristles black ; oc. rather long but thin ; or. 2 + 2. Thorax shining black on the back, with two parallel bands of whitish pubescence, one in front of the suture, the other in front of the dc., while the remaining pubescence is black. Humeri whitish, united with a broad whitish oblique stripe on upper part of the shining black pleurae, extending to the pteropleura. All the bristles black ; one mpl. ; dc. placed only a little behind the line of the a. sa. Scutellum broad, rather flattened above, entirely whitish, unspotted, with four bristles ; post-scutellum and mesophragma shining black ; six white hypopleural spots. Calypteres and halteres blackish. Abdomen shining black and with short black pubescence, but with two bands of whitish hairs at hind border of first and third segment ; apical bristles black. Legs with reddish brown coxae and femora, the latter paler on basal half ; tibiae and tarsi whitish, the four anterior tibiae darkened basally ; bristles of front femora black ; hind femora with a row of 5–6 bristles outwardly near the end ; hind tibiae with short ciliation behind ; middle tibiae with one black spur. Wings elongate, with a short costal bristle ; second vein straight and long ; last portion of third and fourth veins distinctly curved below at end and nearly parallel ; third

vein bristly throughout its whole length; small cross-vein a little beyond middle of discoidal cell; hind cross-vein straight and only a little outwardly oblique; prolongation of anal cell long, but a little shorter than the second basal cell. Wing-pattern blackish, very peculiar; it consists of a broad band at base and at costa, without hyaline indentations at fore border, even the stigma being completely black; the lower margin of this band begins at end of anal cell and goes obliquely across the basal half of discoidal cell and a little beyond the small cross-vein to the third longitudinal vein; there is there a complete middle band, which extends to hind border, passing a little beyond middle of last portion of fourth vein; the fuscous costal border is continued to the wing tip, ending about mid-way between ends of third and fourth veins; the submarginal cell is entirely black. The posterior half of wing is quite hyaline, except the above-named middle band; there is no trace of infuscation of the hind cross-vein. The base of wing is quite black, without any trace of hyaline streaks.

Type ♂ and an additional specimen of same sex from Nyasaland, Ruo, 200 ft., 9. ix. 1916, "on tassels of maize" (*R. C. Wood*); named in honour of the collector.

4. Carpophthoromyia angusticeps, ~~sp. n.~~ 57

A species from Central Africa, to be fully described elsewhere.

5. Carpophthoromyia procera, Enderlein, Zool. Jahrb. xliii, Abt. f. Syst., p. 345, 1920 (*Ceratitis*).

Described from West Africa.

6. Carpophthoromyia nigribasis, Enderlein, *l.c.*, p. 346, 1920 (*Ceratitis*).

Described from Spanish Guinea.

7. Carpophthoromyia tessmanni, Enderlein, *l.c.*, p. 345, 1920 (*Ceratitis*).

Also a West African species.

8. Carpophthoromyia superba, Bezzi, 1918.

Numerous specimens of both sexes from Nyasaland, Cholo, 2,600 ft., 4. x. 1919 (*R. C. Wood*).

The hitherto undescribed male is like the female; last abdominal segment ferruginous at hind border; genitalia shining reddish-brown, prominent below.

14. Leucotaeniella, Bezzi, 1918.

The *Trypeta grata* of Wiedemann, of which I have now seen specimens, is better placed here than in *Clinotaenia*; it forms a transition to the preceding genus in the blacker coloration of the body, being distinguished by the different wing-pattern which is very like that of *trispila*.

The species are as follows:—

1 (2). Scutellum with three broad quadrate shining black spots; body prevalently black; femora black in part ... ... *grata*, Wied.
2 (1). Scutellum with one or three small rounded dark spots; body reddish; femora pale yellowish.
3 (6). Scutellum with a single black spot, the apical one (not counting the spots on the postalar calli); wing-bands broad, the basal one complete.
4 (5). Wing-bands separated, except the usual points of contact *trispila*, Bezzi.
5 (4). Wing-bands partly fused together, with hyaline rounded spots between them, appearing almost reticulate ... ... *guttipennis*, Bezzi.
6 (3). Scutellum with three black spots; wing-bands narrow, the basal one less distinct ... ... *pentaspila*, Bezzi.

15. **Chelyophora,** Rondani, 1875.

The species are as follows :—

1 (2). Basal yellowish band of wings divided superiorly by a hyaline indentation, which extends below the fourth vein ; the basal band is, moreover, united with the cubital and the marginal bands ... ... *magniceps*, Bezzi.

2 (1). Basal band entire above and quite separated from all the others *woodi*, sp. nov.

1. Chelyophora magniceps, Bezzi, 1918 ; *lemniscata*, Enderlein, Zool. Jahrb. xliii, Abt. f. Syst., p. 355, 1920.

One male specimen from Uganda, 20-30. ix. 1918, and one ♀ from Kampala, 7. ix. 1918 (*C. C. Gowdey*).

This species, originally described from the Sudan, seems to be widely spread over Central Africa ; it is impossible to distinguish it from *lemniscata*, described from East and West Africa.

The hitherto undescribed male is very like the female and has the same very peculiar wing-pattern ; the genitalia are shining reddish, prominent below but not visible from above.

2. Chelyophora woodi, sp. nov.

Very like the preceding species, but smaller and distinguishable by the wing-pattern, which is like that of the Oriental *separata*, Bezzi, having the costal border interrupted at the stigma.

♂ ♀. Length of body 5 mm. ; of wing 5 mm. ; of ovipositor 1 mm.

Head, its appendages and chaetotaxy exactly as in *magniceps* ; the fuscous spot in the middle of frons is less developed. Thorax and scutellum as in *magniceps*, like the halteres and abdomen ; the ovipositor is much shorter, being only one-half as long. Legs entirely pale yellowish, unspotted. Wing-neuration as in *magniceps*, but the small cross-vein is placed much beyond the middle of the discoidal cell, its distance from the hind cross-vein being not greater than its own length. The wing-pattern is of the same coloration and of the same shape in general ; but the basal band is of equal breadth throughout, being neither dilated nor divided above ; it is, moreover, perfectly perpendicular and is quite separated from all the others, the costal border being interrupted at stigma, the stigma itself being hyaline on its distal half (in *magniceps* the hyaline part of stigma is included in the hyaline indentation of fore border). The rest of the pattern is as in *magniceps*, but there are two fuscous marginal spots in the submarginal cell ; and the end of the marginal band is more intensively and more broadly infuscated, like the ends of the median and cubital bands.

Type ♂, type ♀ and some additional specimens from Nyasaland, Cholo, x. 1919, collected by *R. C. Wood*, in whose honour this fine insect is named.

16. **Bistrispinaria,** Speiser, 1913.

Only one species, *fortis*, Speiser, rather widely spread in Central Africa.

17. **Clinotaenia,** Bezzi, 1920.

Excluding *grata*, there is only one species known, *anastrephina*, Bezzi, likewise from Central Africa.

18. **Ceratitis,** McLeay, 1829, s.str.

The two species may be distinguished as follows :—

1 (2). Wings with the cubital band isolated and with no dark spot on last section of fourth vein ; frontal appendages of male inserted near the eyes, short and with the terminal dilation acute and black ... *capitata*, Wied.

2 (1). Cubital band united with the basal one at the small cross-vein ; last portion of fourth vein crossed by an oblique fuscous spot ; the above-named appendages inserted near the middle of frons and with white truncate spatula ... ... *catoirii*, Guér.

1. Ceratitis capitata, Wiedemann.

One female specimen from Durban Botanical Garden, 30. v. 1903 (*F. Muir*).

19. Pterandrus, Bezzi, 1918.

The species are as follows :—

1 (16). Wings destitute of an oblique dark band across the last section of the fourth longitudinal vein.
2 (3). Arista with very short pubescence ; thorax with deep black spots at sides *podocarpi*, Bezzi.
3 (2). Arista with rather long plumosity ; thorax without such spots.
4 (9). Middle femora feathered beneath.
5 (8). Middle tibiae feathered ; marginal band separated.
6 (7). Middle tibiae broadly feathered ; ovipositor short, measuring only 1 mm. in length ... ... *anonae*, Grah.
7 (6). Middle tibiae narrowly feathered ; ovipositor twice as long *colae*, Silv.
8 (5). Middle tibiae not feathered ; marginal band united with the basal one *pinnatifemur*, End.
9 (4). Middle femora not at all feathered.
10 (15). Middle tibiae feathered ; hind tibiae simple.
11 (14). Wing-pattern complete, with a separated marginal band.
12 (13). Abdomen without black bands ... ... *rosa*, Karsch.
13 (12). Abdomen with well-developed black bands ... ... *fasciventris*, Bezzi.
14 (11). Wing-pattern reduced to some isolated dark spots, which do not form regular bands ... ... *pauper*, sp. n.
15 (10). Middle tibiae simple ; hind tibiae feathered ; marginal band united with the basal one ... ... *penicillatus*, Big.
16 (1). Wings with a distinct oblique dark streak across middle of last section of fourth vein.
17 (20). Ocp. black as usual ; frontal bristles normal and black ; tibiae feathered ; legs in part black, with black feathering.
18 (19). Femora mainly yellowish ; thorax yellowish on the back and with an indistinct whitish pleural stripe ... ... *rubivorus*, Coq.
19 (18). Femora mostly black ; thorax black on the back and with a distinct whitish mesopleural stripe ... ... *volucris*, Bezzi.
20 (17). Ocp. pale yellowish ; s. or. thickened and yellowish ; tibiae not feathered ; legs entirely yellowish, with the four posterior femora with yellowish feathers ... ... *cornutus*, Bezzi

1. Pterandrus podocarpi, Bezzi, Ann. S. Afr. Mus. xix, p. 476, 1924.

A recently described South African species.

2. Pterandrus rosa, Karsch, 1887.

One ♀ from Nyasaland, Limbe, 4,000 ft., "at flowers of mango," 22. ix. 1916 (*R. C. Wood*).

3. Pterandrus pauper, sp. nov.

Distinguished from all the other species by the much reduced wing-pattern, and by having only the middle tibiae feathered.

♂. Length of body, 4 mm. ; of wing, 4 mm.

Head entirely yellowish ; occiput opaque, with a thin, whitish dust, and with whitish hairs below ; there is a narrow, transverse black streak above. Frons

opaque, whitish yellow, with a triangular dark spot in the middle on the anterior half ; ocellar dot black ; face whitish, like the linear parafacialia ; peristomialia yellowish. Antennae entirely pale yellowish ; third joint rounded at end, a little shorter than the face ; arista shortly plumose, the plumosity being not broader than the breadth of third antennal joint. Palpi and proboscis yellowish, cephalic bristles black ; oc. strong ; two i. or. Thorax blackish on the back, but clothed with dense opaque dark grey dust ; before the suture there are three narrow black stripes, the middle one of which is dilated behind and there divided into two diverging branches ; there are, moreover, four black round spots, two near the dc. and two at suture ; the area in front of scutellum is broadly yellowish. Humeral callosities whitish. Pleurae reddish brown, with partly yellowish mesopleurae. The pubescence of back is yellowish ; all the bristles are black ; dc. placed a little behind the line of a. sa. ; only one mpl. Scutellum pale yellowish, rather shining, with three black spots, the middle of which is the largest and lies between the apical bristles, while the smaller lateral ones are at the insertion of the lateral bristles. Postscutellum yellowish ; mesophragma dark grey dusted ; two contiguous whitish hypopleural spots. Halteres pale yellowish. Abdomen with whitish pubescence and some black bristles at end ; first segment blackish, with a broad yellowish band at hind border ; second segment with the hind half black and rather shining ; third segment clothed with whitish dust ; fourth segment yellowish with darker base. Genitalia shining reddish. Legs entirely pale yellowish, only the middle tibiae with the terminal half blackish ; femora not at all feathered, those of front pair with a single row of long black bristles below ; middle tibiae narrow at base, broad on terminal half and there broadly feathered with black cilia ; hind tibiae with a row of short black bristles at hind border. Wings hyaline, with dark yellowish veins ; the pattern is very pale and is reduced to a narrow interrupted band from the small cross-vein through the base of discoidal cell to the end of anal vein ; a dark streak on each side of humeral cross-vein, and a small dot on middle of fore border of the second costal cell ; stigma pale yellowish a dark streak on the middle and a rounded spot at end of the marginal cell, and a dark spot at end of the third longitudinal vein ; hind cross-vein narrowly bordered with fuscous, even along the last part of fifth vein. There are some scattered dark streaks at the extreme base of wing. Small cross-vein before middle of discoidal cell. Costal bristle black, short but strong.

Type ♀, a single specimen from Gold Coast, Oblogo, 25. xii. 1920 (*Dr. J. W. Scott Macfie*).

4. Pterandrus volucris, Bezzi, 1918.

A couple of specimens from Nyasaland, Limbe, 24. xii. 1916 (*R. C. Wood*). The hitherto unknown female is like the male, but the femora are less blackened and the middle tibiae are quite yellowish ; ovipositor reddish and short, being not longer than the last two abdominal segments together. In these specimens the infuscation of the legs seems to be less intense than in the type described from British East Africa ; the oblique dark streak across the middle of last section of fourth vein is more distinct in the female than in the male.

5. Pterandrus cornutus, Bezzi, Ann. S. Afr. Mus. xix, p. 478, 1924.

A recently described species from South Africa.

20. Pardalaspis, Bezzi, 1918.

The rather numerous species of the present genus, with the addition of some new ones, are as follows :—

1 (30). Wings without a complete middle band across the last section of fourth longitudinal vein, or very rarely with a small isolated streak there ; the cubital band (that is the one across the hind cross-vein) quite isolated.

2 (29). Scutellum with three or five black spots at hind border, or rarely entirely black there.

3 (26). Black spots of scutellum very broad, quadrate or rectangular in shape, closely approximated or even fused together, and nearly covering the whole surface.

4 (5). Wings with the marginal band isolated; arista shortly plumose *morstatti*, Bezzi.

5 (4). Wings typically with the marginal band broadly united at stigma with the basal one; when they are separated, the arista is pubescent only, not plumose.

6 (25). Last portion of fourth vein destitute of an oblique dark streak across the middle.

7 (10). Two strong mpl.; frons of male shining white; species of greater size, measuring at least 8 mm. in length.

8 (9). Thorax dark, with blackish spots at sides; face of male entirely black; abdomen punctate; wings with infuscated bands and numerous basal streaks ... ... *punctata*, Wied.

9 (8). Thorax pale reddish, quite unspotted; face of male with a yellow band at root of antennae; abdomen not punctate; wings with pale yellowish bands and less numerous basal streaks ... *brêmei*, Guér.

10 (7). Only one strong mpl. as a rule; head of male not so strikingly coloured; smaller species, not over 7 mm. in length.

11 (14). Scutellum entirely black, with a narrow yellow base; the black parts of mesonotum are more developed than the yellow ones.

12 (13). Occiput with broad, shining black spots above; pvt. black; marginal band united with the basal one ... ... *melanaspis*, Bezzi.

13 (12). Occiput only slightly infuscated above; pvt. white; marginal band broadly separated beyond stigma ... ... *asparagi*, Bezzi.

14 (11). Scutellum yellow, with separated black spots; yellowish parts of back, as a rule, more developed than the black ones.

15 (18). Dark species, with infuscated back of mesonotum, and with fuscous bands and streaks on wings.

a (*b*). Sternopleura shining black; front legs of male with a striking black and white pattern; marginal band united ... ... *pedestris*, Bezzi.

b (*a*). Sternopleura reddish, front legs in both sexes with usual coloration.

16 (17). Marginal band united; arista shortly plumose; no deep black notopleural spots at sides of mesonotum; abdomen with a black band on second segment ... ... *roubaudi*, sp. nov.

17 (16). Marginal band separated; arista shortly pubescent; deep black spots above the notopleural suture; no such band on second abdominal segment or a very narrow one... ... *Pterandrus podocarpi*, Bezzi.*

18 (15). Paler species, with reddish or yellowish back, and without black bands on abdomen; wing-bands pale yellowish.

19 (24). Humeral callosities with a distinct black spot; sides of thorax with black spots before the suture; scutellum with two basal black spots besides the apical ones.

20 (21). Back of mesonotum, in front of scutellum, with two broad black spots, which are margined behind with yellow; pvt., vt. and scp. all black; bristles of front femora black ... ... *cosyra*, Walk.

21 (20). Back with two small and often indistinct dark spots; pvt. and outer vt. yellowish, like the bristles of front femora.

22 (23). A rather dark species, with complete yellowish basal band on wings; basal black spots of scutellum distinct; ocp. black... *giffardi*, Bezzi.

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* Repeated here because the generic position is doubtful, the male being unknown.

23 (22). A much paler and smaller form, with incomplete basal band on wings; basal spots of scutellum hardly visible; ocp. yellowish *sarcocephali*, var. nov.
24 (19). Humeri and sides of thorax before the suture destitute of black spots; scutellum with no distinct basal spots... ... ... *silvestrii*, Bezzi.
25 (6). Last section of fourth vein crossed in the middle by a well developed oblique dark streak; wings short and broad... ... *antistictica*, Bezzi.
26 (3). Black spots of scutellum much smaller and broadly separated, the outer ones being more rounded; the scutellum therefore mainly yellow.
27 (28). Scutellum with three black spots; wings with the marginal and basal bands wholly separated beyond the stigma... ... ... *flexuosa*, Walk.
28 (27). Scutellum with five spots; the two above-named bands united *quinaria*, Bezzi.
29 (2). Scutellum with only two black spots; back of mesonotum with a white middle stripe ... ... *bipustulata*, sp. nov.
30 (1). Wings with a more or less complete middle band, or with the cubital band not isolated.
31 (34). Marginal band united with the basal one at the stigma.
32 (33). Scutellum with the three usual black spots; wings with yellowish bands, the cubital one united with the basal; middle band not complete *stictica*, Bezzi.
33 (32). Scutellum with the basal half pale yellowish, the apical half shining black; wings with fuscous bands, the cubital one isolated, the middle one complete and united with the marginal; back of mesonotum black, with bluish sides ... ... *cyanescens*, sp. nov.
34 (31). Marginal band separated from the basal one beyond the stigma; cubital band united with the marginal one; middle band complete *aliena*, Bezzi.

1. Pardalaspis punctata, Wiedemann, 1824.

Tephritis senegalensis, Macquart, 1835, is certainly the female of the present species, chiefly on account of the description of the head and wing-pattern, and of the punctate abdomen.

2. Pardalaspis brêmei, Guérin, 1843.

A large species, closely allied to the preceding one, but very distinct on account of the paler coloration of the body and wings, the back of the mesonotum being practically destitute of black spots.

Two male specimens from Gold Coast, N. Territories, Yapi, 1–4. vi. 1919 (*Dr. J. J. Simpson*), and Accra, iv. 1921 (*Dr. J. W. Scott Macfie*). The species, originally described from Senegal, having never been found subsequently, I will give here a redescription of it.

♂. Length of body 7–7·5 mm.; of wing 7 mm.

Head entirely whitish yellow, with quite unspotted occiput. Frons white, almost argenteous, unspotted or with a very faint, pale yellow elongate spot in the middle; it is very broad, of nearly quadrate shape. Face white, unspotted, but with the upper half of the same orange colour as the antennae, forming a striking band; peristomialia white, unspotted; palpi and proboscis yellowish. Antennae short, not exceeding the middle of face; they are of uniform orange colour; third joint rounded at end; arista with much shorter pubescence than in *punctata*. All the bristles black; 2 i. or.; oc. rather thin. Thorax entirely pale yellowish, clothed with whitish dust on the back; it is quite unspotted, except a black spot on postalar calli, which is shiny anteriorly and velvety posteriorly; pleurae unspotted, but the mesopleura with two indistinct whitish bands; hairs whitish. Humeral calli,

hypopleural spots and mesophragma white. Scutellum white on the basal half, yellowish on the apical, and there with three broad rectangular shining black spots. All the bristles black, except the middle ocp. which are yellowish; dc. a little behind the line of a. sa.; two equally strong mpl., like in *punctata*; pt. long and strong; four sct. Halteres pale yellowish. Abdomen of same colour as back of mesonotum, unspotted or with very faint dark spots recalling those of *punctata*; pubescence pale yellowish, white at sides on the base; last segment with some black bristles. Venter reddish, white-dusted; genitalia dark reddish or brown. Legs entirely pale yellowish, unspotted; pubescence whitish; front femora with four black bristles below; posterior coxae with black bristles. Wing-pattern like that of *punctata*, but the bands are pale yellowish; the dark basal spots are less numerous; the four marginal spots (two on each side) of the marginal band are more striking on account of the paler coloration of the band.

3. Pardalaspis asparagi, Bezzi, Ann. S. Afr. Mus. xix, p. 480, 1924.

A recently described South African species.

4. Pardalaspis pedestris, Bezzi, Ann. S. Afr. Mus. xix, p. 480, 1924.

A recently described species from South Africa.

5. Pardalaspis roubaudi, ~~sp. nov~~. 8

A species from the Congo that will be more fully described elsewhere.

6. Pardalaspis giffardi, Bezzi, 1912.

Having been able to study numerous specimens, I have come to the conclusion that *giffardi* must be considered as distinct from *cosyra*, Walker, at least as a variety.

Of the true *cosyra* I have before me some authentic specimens, compared with Walker's types. They all agree in being darker in general coloration; in having entirely black cephalic bristles; in having black bristles on underside of front femora; and in having two broad rounded black spots in front of scutellum which are margined behind with yellow.

The typical specimens of *giffardi*, from Dakar, Senegal, as figured by me and by Prof. Silvestri, have on the back, in front of scutellum, only two very small black spots, not margined behind with yellow, at insertion of prsc. Moreover, the pvt. and the outer vt. are reddish yellow, like the bristles on underside of front femora.

The species was bred from fruits of *Chrysobalanus* by Prof. Silvestri, each fruit usually with only two larvae, and never more than five; other specimens were from Guinea, Konakry, and from Dahomey.

7. Pardalaspis giffardi var. **sarcocephali,** nov.

The specimens bred by Prof. Silvestri in Southern Nigeria, from fruits of *Sarcocephalus esculenta* (even 34 larvae living in one fruit), and previously referred by me to the preceding species, must be distinguished at best as a variety, under the above name.

Length of body not over 4 mm. (in *giffardi* 5 mm.). They are considerably smaller, and of a much paler coloration. Back of mesonotum paler; pleurae quite whitish; praescutellar black spots small and not margined with yellow behind; basal black spots of scutellum indistinct; ocp. and other bristles of hind part of head pale yellowish, like the bristles on underside of front femora; basal yellowish band of wing more indistinct on posterior half.

8. Pardalaspis bipustulata, ~~sp. nov.~~

This Central African species is very distinct from all the others on account of the two broad black spots on the scutellum. Two female specimens from Nyasaland, Ruo, 200 ft., 20 iv. 1922 (*R. C. Wood*).

The collector appended this note on the colour of the eyes: "Bright emerald iridescent green, with a movable reddish-brown patch below surface."

The female agrees with the male, but the whitish middle stripe of the back of the mesonotum is less distinct. Ovipositor entirely yellowish, not longer than the last two abdominal segments together. Very characteristic are the broad hyaline spots in the costal yellowish band, at the end of the marginal and submarginal cells.

9. Pardalaspis cyanescens, ~~sp. nov.~~

A very distinct species from Madagascar that will be more fully described elsewhere.

10. Pardalaspis aliena, Bezzi, 1920.

Of this very distinct species, described from the Cape, there is a well-preserved female specimen from Nyasaland, Cholo (*R. C. Wood*). The third antennal joint is entirely yellowish, rounded at end; arista with very short and equal plumosity. Or. 2+2. The very peculiar wing-pattern is exactly as described; the fusion of the cubital band with the marginal one is even more complete than in the type, the base of the band being as deeply yellowish as the rest.

21. Perilampsis, Bezzi, 1920.

The species are as follows:—

1 (6). Marginal band of wing not interrupted in its terminal part; base of wing with dark dots.

2 (5). Wings with a complete middle band, issuing from the marginal band and extending across the last section of fourth vein to the hind border; mesopleural stripe yellow.

3 (4). Back of mesonotum and abdomen shining black; basal dark band of wings perpendicular and separated from the basal cross-veins ... *pulchella*, Aust.

4 (3). Back and abdomen shining red; basal band oblique and in contact with the basal cross-veins, filling up completely the base of the discoidal and of the third posterior cell ... ... *diademata*, Bezzi.

5 (2). Wings with the middle band reduced to a short stump; mesopleural stripe dark grey... ... ... *arguta*, End.

6 (1). Marginal band broadly interrupted at end of the second longitudinal vein; base of wing without dark spots; middle band reduced to a short stump *formosula*, Aust.

1. Perilampsis diademata, Bezzi, Ann. S. Afr. Mus. xix, p. 482, 1924.

A beautiful, recently described species from South Africa.

2. Perilampsis arguta, Enderlein, Zool. Jahrb. xliii, Abt. f. Syst., p. 354, 1920 (*Ceratitis*).

A recently described West African species.

22. Haplolopha, Bezzi, 1920.

Only one species known, *cristata*, Bezzi, from British East Africa.

23. **Trirhithrum,** Bezzi, 1918.

The numerous species of the present genus, which is characterized chiefly by the rather constant wing-pattern, are as follows :—

1 (4). Thorax densely grey tomentose on back of mesonotum, with shining black sides and with bright yellowish humeri and pleural stripes ; wings with basal streaks and with a complete middle band ; scutellum black, with a sinuous, interrupted yellowish line at base.
2 (3). Face black-spotted above ; humeri yellowish ; length 4 mm. *lycii*, Coq.
3 (2). Face not spotted ; humeri black with a narrow whitish border ; length 2 mm. only ... ... *minimum*, Bezzi.
4 (1). Thorax quite shining black, even on disc of back, on humeri and pleurae.
5 (12). Scutellum flat above, with the base more or less broadly yellow ; wings usually with a complete middle band, extending to hind border across the last section of fourth vein.
6 (9). Scutellum whitish, with three black spots, not visible from above, at hind border ; wings with a complete middle band ; robust species of greater size.
7 (8). Two i. or. and one mpl. ; mesopleura with a whitish stripe ; wings at base with dark spots and hyaline streaks ... ... *validum*, Bezzi.
8 (7). Three i. or. and two mpl. ; no whitish stripe on pleurae ; wings without such basal pattern ... ... *albonigrum*, End.
9 (6). Scutellum shining black on the hind half or more ; species of smaller size.
10 (11). Three i. or., ; wings with complete middle band and with no basal streaks ; pleurae entirely black ... ... *nitidum*, v. Röd.
11 (10). Two i. or. ; middle band reduced to a very short tooth and basal hyaline streaks present ; a whitish mesopleural spot... *albomaculatum*, v. Röd.
12 (5). Scutellum convex above, entirely black even at base, or only with two very small yellow dots below at end ; wings with the middle band reduced to a short tooth, which rarely extends to the fourth vein.
13 (14). Wings without cubital band (that is, destitute of dark band on hind cross-vein) ... ... *patagiatum*, End.
14 (13). Wings with a well-developed cubital band.
15 (20). Wings with isolated cubital band and with basal streaks or dots.
16 (19). Mesopleurae with a white horizontal band at upper border ; wing-base hyaline with a few dark spots ; 5–6 mm. in length.
17 (18). Abdomen with only one whitish band, that at hind border of third segment ; no distinct hypopleural spots ... ... *facetum*, End.
18 (17). Abdomen with two bands, on first and on third segments ; two whitish hypopleural spots ... ... *bicinctum*, End.
19 (16). Mesopleurae without such a broad band ; wing-base black, with numerous hyaline streaks ... ... *basale*, sp. nov.
20 (15). Wings with the cubital band united with the basal one, and destitute of basal streaks.
21 (26). Middle band of wings in the shape of a rather long tooth, which extends to the fourth longitudinal vein.
22 (23). Wing-base hyaline, with an oblique dark band ; halteres pale ; third abdominal segment with two grey spots ; (?) only two scutellar bristles *bimaculatum*, v. Röd.
23 (22). Base of wing black ; halteres black ; third abdominal segment not so spotted ; four sct.
24 (25). Base of wing with one hyaline indentation into the costal cell, and, moreover, with some hyaline streaks ... ... *ochriceps*, End.
25 (24). Entire base of wing uniformly black ... ... *homogeneum*, sp. nov.
26 (21). Middle band in the shape of a very short tooth, which is often indistinct.

27 (32). The short pubescence on the back of mesonotum entirely black ; scutellum without yellow dots below in middle of hind border.
28 (31). Third abdominal segment with a complete whitish band at hind border ; size greater (5–7 mm.).
29 (30). Face creamy-white on its lower two-thirds ; wings with a triangular hyaline indentation at fore border before the stigma and with the cubital band narrower than the length of the hind cross-vein *nigrum*, Grah.
30 (29). Face entirely shining black, with only a reddish mouth-border ; wings entirely infuscated before the stigma and with the cubital band as broad as hind cross-vein ... ... *gagatinum*, Bezzi.
31 (28). Third abdominal segment with only two greyish triangular spots towards its middle ; frons and occiput of a bright reddish colour ; size smaller (not over 4 mm.) ... ... *occipitale*, Bezzi.
32 (27). The short pubescence of back entirely whitish ; scutellum with two small yellow dots at hind border.
33 (34). Wings with no hyaline indentation at fore border and with no costal hyaline border to the marginal band ... ... *nigerrimum*, Bezzi.
34 (33). A well-developed hyaline indentation, and a narrow but distinct hyaline stripe at upper border of marginal band.
35 (36). Tibiae broadly yellowish ; face cream-white ... ... *leucopsis*, Bezzi.
36 (35). Tibiae entirely or mainly black ; face more or less darkened, at least above.
37 (38). Face darkened only above ... ... *inscriptum*, Grah.
38 (37). Face entirely darkened ... ... *festivum*, End.

1. Trirhithrum minimum, Bezzi, Ann. S. Afr. Mus. xix, p. 484, 1924.

A recently described South African variety of *lycii*, Coq.

2. Trirhithrum patagiatum, Enderlein, Zool. Jahrb. xliii, Abt. f. Syst., p. 350, 1920 (*Ceratitis*).

A recently described species from Nyasa.

3. Trirhithrum facetum, Enderlein, *l.c.*, p. 349, 1920 (*Ceratitis*).

A recently described West African species.

4. Trirhithrum bicinctum, Enderlein, *l.c.*, p. 349, 1920 (*Ceratitis*).

Very distinct on account of the isolated cubital band, the basal black dots on the wing, the white mesopleural stripe and the two white cross-bands on the abdomen. A female specimen from Gold Coast, Accra, iii. 1921 (*Dr. J. W. Scott Macfie*). Originally described also from Accra ; but as Enderlein has only a short comparison with *facetum*, a regular description will be given here.

Length of body 4·5 mm. ; of wing 4 mm.

Occiput black above, whitish below, with a shining yellowish band on the vertical region. Frons broad, only a little longer than broad, opaque, pale yellowish, with a complete dark cross-band in the middle. Face whitish, with a narrow yellowish cross-band at root of antennae ; parafacialia and peristomialia whitish, the latter unspotted. Antennae dark reddish, shorter than the face ; third joint rounded at end ; arista with short plumosity, which is not longer than the breadth of third antennal joint. Palpi and proboscis pale yellowish. All the bristles black, two i. or. Thorax shining black, with dark yellowish pubescence on the back ; in front of scutellum there are two narrow yellowish spots, one on each side ; humeri black, margined below with whitish. Pleurae shining black and black-haired ; a broad whitish band on upper border of mesopleura, extending from the humeri to the root of wings ; a double whitish hypopleural spot. Scutellum entirely shining black, with a very narrow and sinuous yellowish band at base. Bristles black ; one mpl.;

dc. placed a little behind the line of a. sa.; four sct. Abdomen shining black, with a broad whitish cross-band on first and third segments ; last segment dark reddish in the middle of posterior half ; pubescence black, but white on the whitish bands ; terminal bristles black ; ovipositor as long as the last two segments together, with reddish base and black terminal half. Legs black, with black bristles and dark pubescence ; first tibiae entirely, and terminal parts of four posterior tibiae and tarsi, yellowish. Wings with a blackish pattern ; the base hyaline, with a dark band from the humeral cross-vein to the base of anal cell, and subsequently with a few black dots, two of which are in the second costal cell ; stigma black, with the tip pale ; basal band even, perpendicular, extending from the stigma to the end of the anal vein ; marginal band complete, extending below to the third vein and at end to the middle of the first posterior cell, with the usual four black marginal dots and the hyaline costal stripe ; no trace of middle band, not even as a tooth ; cubital band slightly exceeding the fourth vein above, but always broadly separated from the anal one ; axillary lobe hyaline. Third and fourth veins parallel at end ; small cross-vein before middle of discoidal cell.

5. Trirhithrum basale, sp. nov.

Allied to the preceding species, but smaller, without the broad mesopleural band, and with black base to the wing, in which are numerous hyaline streaks.

♂ ♀. Length of body 3·5 mm. ; of wing 3 mm.

Occiput opaque black, with a pale yellowish border, which is broadened below on the lateral swellings. Frons narrow, about twice as long as broad, of a dark colour, opaque, unspotted, with paler stripes at sides and in front ; ocellar dot black. Face of the same dark colour, but clothed with a faint whitish dust. Antennae yellowish, a little shorter than the face ; third joint attenuated, but rounded at end ; arista with long plumosity which is twice as long as the breadth of third antennal joint. Proboscis and palpi dark. Bristles black ; two i. or. Thorax shining black, with pale yellowish pubescence, and with indistinct longitudinal grey stripes ; humeri whitish with a central black spot. Pleurae dark brownish, with black pubescence and with a very narrow whitish line at notopleural suture. Bristles black ; only one mpl. Scutellum shining black, with four bristles ; a very small yellowish spot on each side near the base. Postscutellum shining black ; mesophragma black, grey-dusted ; no distinct hypopleural spots. Halteres dark reddish-brown. Abdomen shining black, variegated with grey dust, forming spots and short stripes ; pubescence mainly dark ; bristles black. Male genitalia reddish ; ovipositor shining reddish, not longer than the last abdominal segment. Legs with blackish femora and yellowish tibiae and tarsi, but the four posterior tibiae darkened basally ; bristles black. Wings with blackish pattern ; base entirely blackish, with the costal cell hyaline with two black dots, the rest with numerous hyaline streaks ; axillary lobe blackish, with paler lower external corner. Stigma black, with the exterior corner paler. Basal band united with the black base ; marginal band with the usual 4 black dots and the hyaline costal stripe ; a short but distinct tooth, representing the middle band ; cubital band as a rule isolated, but sometimes united by a faint shade with the basal band. In immature specimens the dark pattern is more diffused. Second longitudinal vein distinctly curved towards its middle ; last sections of third and fourth parallel ; small cross-vein before middle of discoidal cell.

Type ♂, type ♀, and some additional specimens from Nyasaland, Cholo, 3,000 ft., viii. 1918, xi. 1919 (*R. C. Wood*).

6. Trirhithrum ochriceps, Enderlein, *l.c.*, p. 347, 1920 (*Ceratitis*).

This species, described from British East Africa, seems to be the same as *occipitale*, Bezzi, 1918.

7. Trirhithrum homogeneum, sp. nov.

A species from East Africa that will be fully described elsewhere.

8. Trirhithrum nigerrimum, Bezzi, 1913.

The present species was redescribed by Enderlein, *l.c.*, 1920, p. 348, and previously named *Ceratitis dispertita* (p. 349).

9. Trirhithrum leucopsis, Bezzi, 1918.

Two male specimens from Nyasaland, Cholo, xi. 1919 (*R. C. Wood*).

10. Trirhithrum inscriptum, Graham, 1910 (*coffeae*, Bezzi, 1918).

One male specimen from Gold Coast, Accra, on laboratory windows, x. 1920 (*Dr. A. Ingram*).

11. Trirhithrum festivum, Enderlein, *l.c.*, p. 349, 1920 (*Ceratitis*).

A recently described species from West Africa, Spanish Guinea.

24. Xanthorrhachista, Hendel, 1914.

Only one species known, *X. aluta*, Becker, 1910 (*cephalia*, Hendel, 1914).

25. Themarictera, Hendel, 1914.

The recently erected genus *Stigmatothemara*, Enderlein (Zool. Jahrb. xliii, Abt. f. Syst., p. 340) is certainly the same.

It is possible that there is only one species in this genus, the very old *flaveolata*, the others being only variations of it ; the type species *rufipennis*, Hendel, was not described, but is probably identical with *flaveolata* or with *pterocallina*.

1 (4). A black round spot on each side of thorax, just above the humeri.

2 (3). Submarginal and first basal cell, each with a rounded hyaline spot *laticeps*, Loew.

3 (2). The above-named cells without such spots ... ... *flaveolata*, Fabr.

4 (1). No black spots in front of thorax (at least they are not mentioned in original description) ; no hyaline rounded spots in submarginal and basal cells ... ... *pterocallina*, End.

1. Themarictera pterocallina, Enderlein, *l. c.*, p. 340, 1920 (*Stigmatothemara*).

Recently described from North Cameroons ; probably the same as *flaveolata*, F.

26. Themara, Walker, 1856.

The following species from the Ethiopian fauna are at present known :—

1 (4). Pterostigma with its distal end hyaline, included in the poststigmatic hyaline spot, which does not extend downwards beyond the second longitudinal vein ; hyaline middle spots linear.

2 (3). No hyaline spot in the last part of discoidal cell below the small cross-vein *fallacivena*, End.

3 (2). A hyaline spot in the discal cell below small cross-vein *trispila*, var. nov.

4 (1). Pterostigma entirely black to the end ; poststigmatic spot extending beyond second longitudinal vein ; hyaline middle spots broad and rounded ... ... *speiseriana*, sp. nov.

1. Themara trispila, var. nov.

A variety of *fallacivena* from the Congo.

2. Themara speiseriana, sp. nov.

A West African species that will be more fully characterized elsewhere.

27. Baryglossa, Bezzi, 1918.

Of this peculiar genus, very aberrant in structural features and in wing-pattern, there are now two species known, as follows :—

1 (2). Scutellum black-spotted at end ; abdomen opaque yellow, with broad black pattern ; wings with a few hyaline spots of greater size irregularly distributed ... ... *histrio*, Bezzi.

2 (1). Scutellum not spotted ; abdomen shining reddish, with three small black spots on each segment, except the first ; wings with numerous sub-hyaline dots of smaller size, disposed in regular longitudinal rows *bequaerti*, Bezzi.

1. Baryglossa bequaerti, Bezzi, Rev. Zool. Afr. xii, p. 14, 1924.

A recently described species from Congo.

28. Ptiloniola, Hendel, 1914.

The known species are as follows, after excluding *preussi*, Hendel, which is said to have the hind femora bristly below.

1 (2). Thorax with two blackish stripes on each side ; wings with three well-developed discoidal hyaline spots, the external one placed near the hind cross-vein ... ... *tripunctulata*, Karsch.

2 (1). Thorax with only one stripe on each side, wings with the hyaline spots less developed, that in discoidal cell being placed near the small cross-vein *neavei*, Bezzi.

1. Ptiloniola neavei, Bezzi, 1918.

Numerous specimens of both sexes from Nyasaland, Cholo, x. 1919 (*R. C. Wood*).

29. Rhacochlaena, Loew, 1862.

The species seem to be common in the Ethiopian Region, and have all a wing-pattern not much different from that of the European species *toxoneura*, which, however, has no hyaline spot at the end of the pterostigma. They are as follows :—

1 (8). Three i. or. ; wings with a distinct whitish spot at end of first posterior cell, and with more or less complete cross-bands.

2 (7). Arista with short pubescence ; ovipositor reddish, and shorter than the abdomen.

3 (6). Wings with a broad fuscous apical band, the terminal part of the first posterior cell and the second posterior cell being for the most part infuscated.

4 (5). Apical whitish spot of wing broad, extending on both sides beyond the ends of third and fourth longitudinal veins ... *pulchella*, Bezzi.

5 (4). Apical spot small, not extending beyond the first posterior cell ; a hyaline streak in the fuscous part of the first posterior cell ; anal band of wing much developed ... ... *hammersteini*, End.

6 (3). Wings without such a broad terminal band, the last half of first posterior cell and the second posterior cell being almost completely hyaline *fasciolata*, Loew.

7 (2). Arista with rather long plumosity ; ovipositor black and as long as the abdomen ; wings with no anal band, with a broad fuscous apical patch and with a narrow, whitish apical spot ... ... *major*, sp. nov.

8 (1). Two i. or. ; wings with no distinct whitish terminal spot and without distinct cross-bands ... ... *simplex*, sp. nov.

1. Rhacochlaena pulchella, Bezzi, 1920.

The wing-pattern is somewhat variable, the small hyaline spot at end of second longitudinal vein being present or more or less indistinct ; and the last part of first posterior cell and the second posterior cell are more broadly hyaline. The hitherto undescribed female is like the male, but the abdomen is sometimes yellowish in the middle at base and has the last segment yellow ; the ovipositor is reddish, with black tip, not longer than the last three abdominal segments together.

One male specimen from Gold Coast, Accra, on laboratory windows, viii. 1920 (*Dr. A. Ingram*), and a couple from same locality, also in laboratory, viii. 1919 and iii. 1921 (*Dr. J. W. Scott Macfie*) ; a couple from N.W. Rhodesia, Chilanga, 4,000 ft., in house on window, x.-xi. 1913 (*R. C. Wood*) ; one male from Nyasaland, Ruo, 200 ft., 12 xi. 1915, in house on window (*R. C. Wood*). The domestic habits of the present species are very noticeable.

2. Rhacochlaena major, sp. nov.

A large robust species, with a wing-pattern like that of *hammersteini*, but distinguished from all by the plumose arista and by the long black ovipositor.

♀. Length of body 7 mm. ; of wing 6·5 mm. ; of ovipositor 3 mm.

Occiput yellowish, with not much developed fuscous lateral patches. Frons one and a half times as long as broad, yellowish, infuscated at sides in the middle, rather shining, with black ocellar dot and with a few black, short hairs in the middle ; face shining whitish, infuscated above the mouth-border. Peristomialia unspotted. Antennae as long as the face, entirely yellowish ; plumosity of arista as long as the breadth of third antennal joint. Palpi and proboscis dark. Bristles black ; three equally strong i. or. Thorax and scutellum as in *fasciolata*, with a broad, whitish notopleural stripe, continued to the sides of mesophragma, which is black. All the bristles black ; two strong mpl. Halteres whitish. Abdomen shining black, with a broad yellowish stripe along the middle, extending to the end but darker on the last two segments ; pubescence and bristles black ; ovipositor shining black and black-haired, as long as whole abdomen, cylindro-conical. Legs entirely yellowish, with black bristles and black pubescence ; front femora with three to four bristles below on terminal half. Wing-pattern about as in *hammersteini*, that is, with small apical whitish spot, but without anal fuscous band, with no hyaline spot at end of second longitudinal vein, with the abbreviated fuscous band of fore border not reaching the third vein and extending only a little beyond the second vein ; no hyaline basal streak in the fuscous part of first posterior cell ; hyaline indentation of second posterior cell much smaller, reduced to a rounded marginal spot.

Type ♂, a single specimen from N.W. Rhodesia, Chilanga, 4,000 ft., 9. x. 1913, on tree-trunk along stream (*R. C. Wood*).

3. Rhacochlaena simplex, sp. nov.

Very like *pulchella*, but distinguished from it, as well from all the other species, by having only two i. or., and by the much more reduced wing-pattern.

♂. Length of body 5 mm. ; of wing 4·5 mm.

Occiput whitish, with two broad shining black patches on the sides above. Frons yellowish, bare in the middle, rather concave, infuscated and shining on the basal half ; a black ocellar dot ; only two i. or., black like all the other bristles ; face whitish. Antennae yellowish, with the third joint blackened above and at end, as long as the face ; arista with short plumosity. Proboscis and palpi yellowish. Thorax entirely shining yellowish, with whitish notopleural stripe and with two broad parallel black stripes, extending from the ocp. to the dc. ; scutellum shining yellowish, with a whitish middle stripe, in continuation with a less distinct one on hind part of back. Mesophragma shining black, with yellowish middle stripe. Halteres whitish. Bristles

black, the sct. very long ; two mpl. Abdomen shining black, with a broad complete middle stripe, extending from the base to the end ; pubescence dark, terminal bristles black ; venter yellowish ; genitalia shining black, with a whitish appendage below. Legs entirely yellowish ; front femora without bristles below. Wings hyaline, with the small cross-vein a little beyond middle of discal cell. Stigma blackish, and below this a dark spot in base of marginal cell ; a small dark spot in middle of marginal cell, at the place of the usual abbreviated band of the other species ; a rather broad elongate dark spot at end of submarginal cell, extending above into the upper external corner of marginal cell and below into the upper part of first posterior cell ; no trace of the apical whitish spot ; hind cross-vein narrowly infuscated, the infuscation being continued above into the first posterior cell in the shape of a narrow, indefinite band. No other dark markings present, the small cross-vein being indistinctly infuscated.

Type ♂, a single specimen from Nyasaland, Limbe, 4,000 ft., 24. ix. 1916 (*R. C. Wood*).

30. Taomyia, Bezzi, 1920.

Only two species known, as follows :—

1 (2). One s. or. ; wings with a complete hyaline basal band, extending from the costal cell to the end of the anal cell ... ... *marshalli*, Bezzi.

2 (1). Two s. or. ; wings without such a complete hyaline basal band *ocellata*, Lamb.

31. Phorellia, Robineau-Desvoidy, 1830.

There are two species, as follows :—

1 (2). Wings with four dark bands, the basal one very small *brunithorax*, R.D.

2 (1). Wings with four dark bands, and, moreover, with a dark streak in the marginal cell, between the two middle bands ; basal band regularly developed ... ... *peringueyi*, Bezzi.

1. Phorellia peringueyi, Bezzi, Ann. S. Afr. Mus. xix, p. 488, 1924.

A recently described South African species.

32. Hoplandromyia, ~~gen. nov.~~

A genus established for a species that will shortly be described from Mauritius, *H. tetracera*, Bezzi, differing from the preceding one in the horn-like s. or. of the male ; it differs generically from the Oriental forms ascribed to the genus *Vidalia*.

33. Notomma, Bezzi, 1920.

Only one species, *N. bioculatum*, Bezzi, from which the recently described *Carpophthoromyia fülleborni*, Enderlein (Zool. Jahrb. xliii, Abt. f. Syst., p. 357, 1920) cannot be distinguished. *Trypeta jucunda*, Loew, belongs to the new genus *Hermannloewia*.

34. Pseudospheniscus, Hendel, 1913.

In Ann. Mus. nat. Hung. xiii, 1915, p. 451, Prof. Hendel has corrected his previous error about the type of the present genus, establishing it as *Ps. angulatus*, Hendel, 1913, the genus is thus different from *Spheniscomyia*, and contains species previously placed in *Acidia*, being common to the Oriental and Ethiopian regions.

The three Ethiopian species (*seychellensis*, Lamb, *fossataeformis*, Bezzi, and *homogeneus*, Bezzi) were tabulated by me under the generic name of *Acidia* in my paper of 1920, p. 245, and there is nothing to be added.

1. Pseudospheniscus fossataeformis, Bezzi, 1920.

Some specimens of both sexes from Nyasaland, Chiromo, Ruo R., 2. vi. 1917 (*R. C. Wood*).

35. Afrocneros, gen. nov.

After a long study, I have come to the conclusion that the African species previously placed in *Ocneros* cannot be retained under this name, chiefly on account of the position of the dc. Moreover, the character of the bristles on the third longitudinal vein being not always available, I propose to erect a new genus *Afrocneros*, with the type *excellens*, Loew, for the more robust species, which have two strong mpl., short antennae, shortly pubescent arista, three i. or. with some additional bristly hairs between them, shorter pterostigma, third longitudinal vein bristly to beyond the small cross-vein, etc.; and to place the remaining species under *Ocnerioxa*, even if several of them (*undatus*, *bigemmatus* and *sinuatus*) have a bristly third vein.

In *Afrocneros* there are the following species :—

1 (6). Two strong mpl.; antennae much shorter than the face, with nearly bare arista; pterostigma shorter than the second costal cell; macrochaetae black; scutellum broadly black in the middle.

2 (3). The hyaline indentation at fore border behind the stigma extends into the first posterior cell, reaching the fourth longitudinal vein near the hind cross-vein; the last two abdominal segments of female entirely black *excellens*, Loew.

3 (2). The above-named indentation ends before reaching the third longitudinal vein; the last two abdominal segments of female with a broad, yellowish cross-band, at hind border.

4 (5). The hyaline indentation of face border extends into the submarginal cell; discoidal cell with a hyaline rounded spot in the terminal half; hyaline indentation of second posterior cell extending into the first posterior cell *mundus*, Loew.

5 (4). The above-named indentation not exceeding the second longitudinal vein; terminal part of discoidal cell entirely black, without hyaline spot; posterior indentation ending at fourth vein *mundissimus*, Bezzi.

6 (1). Only one mpl., or the second very thin; antennae about as long as the face, with shortly pubescent arista; stigma as long as or longer than the second costal cell; macrochaetae mostly yellow; scutellum quite yellowish. (See the genus *Ocnerioxa*.)

1. Afrocneros mundissimus, Bezzi, Ann. S. Afr. Mus. xix, p. 490, 1924.

A recently described species from South Africa.

36. Ocnerioxa, Speiser, 1915.

The species of the present genus, as here delimited, are distinguished from those of the preceding one in being of more slender shape and smaller size, in having the body and bristles paler, and in having a more reduced chaetotaxy. The third longitudinal vein is entirely bare, or is bristly only to the small cross-vein, or very rarely has a few scattered bristles on the last section. *Trypeta gracilis*, Loew, previously placed here, belongs to *Allotrypes*.

The rather numerous species can be distinguished as follows :—

1 (2). Base of wings broadly yellowish hyaline; the fuscous part of wing is divided by a broad hyaline band extending from the fore to the hind border of wing, the fuscous margination of hind cross-vein remaining thus quite isolated ... ... *interrupta*, Bezzi.

2 (1). Base of wings quite infuscated; no such hyaline band present, the infuscation of hind cross-vein being united with the infuscation of the discoidal cell; this last cell is entirely infuscated or nearly so.
3 (6). The fuscous part of wing ending below with a straight, not wavy line, without any projection to hind border of wing.
4 (5). Fuscous part of wing narrow, extending only to the middle of the discoidal cell, which is hyaline on its lower exterior half; second posterior cell almost completely hyaline ... ... *pennata*, Speis.
5 (4). Fuscous part extending into the whole discoidal cell, which is completely infuscated; second posterior cell infuscated more than its upper half *undata*, Bezzi.
6 (3). The fuscous part of wing has below more or less developed prolongations, which often extend to the hind border.
7 (8). Fuscous part of wing with a broad middle projection, which ends truncately at a little distance from hind border and parallel with it; only two hyaline spots at fore border; wings of male with a broad yellowish patch on fore half to beyond the small cross-vein ... ... *sinuata*, Loew.
8 (7). Fuscous part with a narrow and acute projection, which reaches usually the hind border along the terminal part of fifth vein.
9 (10). Only two hyaline spots at fore border, one before and one behind the stigma; third vein bristly; face without black markings *bigemmata*, Bezzi.
10 (9). More numerous hyaline spots at fore border, two of which are beyond the stigma; third vein bare; face with the mouth-border black or black-spotted.
11 (12). A black transverse band at mouth-border; frons with a black spot above the antennae; the fuscous projection of wing reaching hind border *woodi*, Bezzi.
12 (11). A small black spot on each side of mouth-border; frons not black-spotted; projection not reaching hind border ... ... *discreta*, Bezzi.

1. Ocnerioxa interrupta, Bezzi, Ann. S. Afr. Mus. xix, p. 491, 1924.

A recently described species from South Africa.

2. Ocnerioxa woodi, Bezzi, 1918.

One male specimen from Nyasaland, Cholo, 2,600 ft., 4. x. 1919 (*R. C. Wood*).

37. Xanthanomoea, Bezzi, 1924.

A recently described genus for a South African species, *X. munroi*, Bezzi, belonging to the group of *Phagocarpus*, with similar wing-pattern, but with prevalently yellow body-coloration (Ann. S. Afr. Mus. xix, p. 493, 1924).

38. Coelotrypes, Bezzi, 1924.

This recently described genus (Ann. S. Afr. Mus. xix, p. 494, 1924) is evidently related to *Coelopacidia* and *Stenotrypeta*, but has a well developed st. and a bare third longitudinal vein; it is therefore placed here in the vicinity of the allied *Allotrypes*.

The present genus is widely distributed over the whole Ethiopian Region, from the Sudan to the Cape, and is present even in Madagascar; it is very curious that I cannot find a trace of it in previous works. *Coelopacidia madagascariensis*, End., may perhaps belong here, being apparently allied to the type species, *vittatus*, Bezzi, but has a different wing-pattern, the apical whitish spot and the subapical blackish patch not being mentioned by Enderlein; even the white middle lines of the thorax and scutellum are not referred to by him.

The known species are as follows :—

1 (4). Prsc. well developed; arista with microscopic pubescence; wings with a rather small apical black spot at end of second and third veins, not surrounding the whitish terminal spots.

2 (3). Mouth-border with a black spot on each side; occiput with two broad black patches; thorax and abdomen with broad black longitudinal stripes ... ... *vittatus*, Bezzi.

3 (2). Mouth-border and occiput without black spots; thorax and abdomen without black stripes or with very narrow ones *pallidus*, sp. nov.

4 (1). No distinct prsc.; arista with rather long pubescence; wings with a broad fuscous band before the whitish terminal spot; mouth-border not black-spotted, but the occiput with black patches *nigriventris*, sp. nov.

1. Coelotrypes vittatus, Bezzi, Ann. S. Afr. Mus. xix, p. 495, 1924.

A recently described species from Central and South Africa and from Madagascar.

2. Coelotrypes pallidus, sp. nov.

Possibly a variety only of *vittatus*, from which it is distinguished by the characters given in the key.

♂ ♀. Length of body 5·5–6 mm.; of wing 4·5–5 mm.; of ovipositor 1·6 mm.

Head entirely reddish. Occiput shining, darker above and paler below, but without black patches, with only a pale yellowish postvertical dot. Frons very shining, unspotted. Face shining pale yellowish, quite unspotted, like the peristomialia. The very long antennae are entirely yellowish, the third joint being not or very little infuscated at end; arista microscopically pubescent. Palpi and proboscis yellowish. Bristles black; ocp. 4–5, forming a row; one s. or. and three i. or.; genal bristle rather strong. Thorax entirely reddish, rather shining, with dark pubescence; on the back there is only a faint trace of the two dark stripes of *vittatus*, but in the female there are two very narrow dorsocentral black lines, extending from the scp. to the dc.; the white postsutural middle stripe is well developed, narrowly margined with black, and continued across the middle of the scutellum, becoming broader there. There is a white notopleural stripe, narrowly margined with black, extending from the humeri to the root of wing. Pleurae unspotted, entirely reddish, like scutellum and mesophragma, the former with the above-mentioned black stripe. Halteres pale yellowish. All the bristles black; prsc. as strong as the dc., which are placed very near to them; one mpl. as strong as the pt. or the st.; scp. rather long and black, those of the middle pair approximated, but not distant from the others. Abdomen shining reddish, with dark pubescence and with black terminal bristles; male genitalia shining black; ovipositor conical, reddish brown, with black pubescence, as long as the last four abdominal segments together. Legs entirely reddish or yellowish, with dark pubescence; front femora with a row of bristles above, but below with a few hairs only. Wings hyaline, iridescent, with yellowish veins. Stigma blackish. A triangular blackish spot at end of second and third veins, extending to the extreme corner of marginal cell, to the end of submarginal cell and of first posterior cell. Hind cross-vein broadly bordered with blackish. There is, moreover, the usual whitish terminal spot, which occupies the end of first posterior cell and extends below into the upper corner of second posterior cell.

Type ♂ and type ♀, a single couple of specimens from Mozambique, 19. vii. 1903 (*F. Muir*).

3. Coelotrypes nigriventris, sp. nov.

Differing from all the other species in lacking the prsc. and in the longer pilosity of the arista; the wings and abdomen are moreover differently coloured.

♀. Length of body 4·5 mm.; of wing 4 mm.; of ovipositor 2 mm.

Head and its appendages as described for the preceding species, but the occiput above with two broad shining black triangular spots; frons with a small black ocellar dot; arista with longer pilosity, nearly short plumose. Bristles black. Back of mesonotum with two broad black longitudinal stripes, which are connected in front and disappear behind; the white middle stripe is narrower and not margined with black, even on the scutellum. White notopleural stripe narrow. Bristles black; there is no trace of prsc. Halteres whitish. Abdomen entirely shining black, even on venter, narrowly reddish only at base; ovipositor reddish brown, with black base. Legs entirely reddish; front femora without bristles below, but with a row at upper side. Wings hyaline, with dark yellowish stigma. The terminal part of marginal, submarginal and first posterior cells with a broad fuscous band, which extends below into the second posterior cell, completely surrounding the usual whitish terminal spot. Fuscous margination of hind cross-vein rather indistinct.

Type ♀, a single specimen from Anglo-Egyptian Sudan, Bundle, 7. iii. 1911 (*H. H. King*).

39. **Hermannloewia,** Bezzi, 1924.

This recently described genus (Ann. S. Afr. Mus. xix, p. 496, 1924), erected on the type *Trypeta jucunda*, Loew, is closely allied to *Notomma*, being distinguished by the form of the head, the quite bare third longitudinal vein, the characteristic shape of the first posterior cell, and by the straight hind cross-vein.

The species seem to be rare, as I have seen only isolated specimens; they are as follows:—

1 (2). Only one s. or.; last portion of fourth longitudinal vein much curved downwards, the first posterior cell being thus three times broader at apex than at base; stigma yellowish; a dark oblique band across last section of fourth vein ... ... *jucunda*, Loew.

2 (1). Two s. or.; last portion of fourth vein nearly straight and destitute of oblique dark band; first posterior cell only twice as broad at the apex as at base; stigma greenish.

3 (4). Distance of cross-veins equal to the length of small cross-vein; hind cross-vein distinctly oblique; an oblique yellowish band extending from small cross-vein to anal cell, the basal half of discoidal cell being thus infuscated *mutila*, sp. nov.

4 (3). Cross-veins more approximated, the hind one perpendicular; no oblique yellowish band present, the discoidal cell being a little infuscated at the extreme base alone ... ... *dissoluta*, sp. nov.

1. Hermannloewia mutila, ~~sp. nov.~~ 8/

A species from Mozambique that will be more fully described elsewhere.

2. Hermannloewia dissoluta, sp. nov.

A new species from the Transvaal that will be more fully described elsewhere.

39a. **Zacerata,** ~~Bezzi~~, 1924. [Coquillet

This recently described genus comprises one South African species, *Z. asparagi*, Bezzi (Ann. S. Afr. Mus. xix, p. 499, 1924).

40. **Urophora,** Robineau-Desvoidy, 1830.

This name is here employed in its usual sense, to replace *Tephritis* of my previous paper. The African species are as follows :—

1 (2). Proboscis short and simple ; scutellum yellow ; apex of wings at end of first posterior cell with a faint greyish shade ; third and fourth veins converging at end ... ... *vernoniicola,* Bezzi.

2 (1). Proboscis long and geniculate ; scutellum black ; wings quite immaculate at end, with the third and fourth veins quite parallel.

3 (4). Legs entirely yellow ; thorax with only the humeri yellowish ; abdominal segments with a narrow yellow hind border ... ... *indecora,* Loew.

4 (3). Legs entirely or in part black ; thorax with yellow humeri and whitish notopleural stripe ; abdomen quite black.

5 (6). Tibiae yellow ; pterostigma infuscated at end ; wing border quite simple *agromyzella,* sp. nov.

6 (5). Tibiae black ; stigma pale yellowish ; wing border with a row of black cilia above stigma and a little beyond it ... ... *cilipennis,* Bezzi.

1. Urophora agromyzella, sp. nov.

Closely allied to *indecora,* Loew, but at once distinguishable by the darker coloration of the legs and abdomen.

♀. Length of body and wing 2·2 mm. ; of ovipositor 1·2 mm.

Occiput entirely black, opaque in the middle and shining towards the sides. Frons reddish opaque, with paler sides and ocellar triangle, and with a black ocellar dot ; it is broad, being at vertex even a little broader than long. Face yellowish, parafacialia and peristomialia whitish, the latter unspotted. Antennae entirely yellowish, as long as the face, with bare arista. Palpi and proboscis yellowish, the latter with the recurrent terminal part a little shorter than the basal one. Bristles black ; two i. or. Thorax entirely shining black, with yellowish humeri, and with whitish notopleural stripe from humeri to the root of wing ; pubescence and bristles black. Scutellum shining black, flattened above, with four bristles. Halteres yellowish. Abdomen shining black, without yellow hind borders, with black hairs and bristles ; ovipositor shining black, black pubescent, as long as the whole abdomen, and if completely exerted as long as the entire body. Coxae black ; trochanters yellowish ; femora black, with narrowly yellow tips ; tibiae yellow ; tarsi yellow, with black terminal joints. Wings hyaline, quite unspotted, only the stigma being yellowish at base and blackish at end. Veins yellowish at base and darkened towards the end ; second and fourth veins perfectly straight and parallel ; small cross-vein about in middle of discal cell ; hind cross-vein straight and perpendicular ; last portion of fourth vein as long as the upper vein of discal cell ; third vein bare ; sixth vein reaching the hind border.

Type ♀, a single specimen from Nyasaland, Cholo, xii. 1919 (*R. C. Wood*).

41. **Allotrypes,** Bezzi, 1920.

Trypeta gracilis, Loew, placed by me erroneously in *Ocnerioxa,* is without any doubt referable to the present genus, and is certainly the same as the type species of it, *A. brevicornis,* Bezzi, 1920. The genus is monotypic, as far as at present known, and is exclusively South African.

42. **Carpomyia,** A. Costa, 1854.

Only one species, *incompleta,* Beck., known as Ethiopian.

43. **Rivelliomima,** Bezzi, 1924.

A genus recently described from South Africa for the species *R. punctiventris,* Bezzi (Ann. S. Afr. Mus. xix, p. 503, 1924), which is very like *Acidioxantha punctiventris,* Hendel, from Formosa.

44. **Craspedoxantha,** Bezzi, 1913.

The known Ethiopian species are as follows :—

1 (6). Two mpl. ; scutellum black-spotted ; back of mesonotum with black spots at sides.
2 (5). Scutellum with one or two spots only ; back of mesonotum blackish grey in the middle ; sternopleura with a black triangular spot below.
3 (4). Scutellum with two rather approximated but distinctly separated black spots at end ... ... *marginalis*, Wied.
4 (3). Scutellum with the two apical spots fused together to form a single black spot ... ... *unimaculata*, Bezzi.
5 (2). Scutellum with four black spots ; thorax entirely yellowish ; with no black spots on back or on sternopleura ... ... *polyspila*, Bezzi.
6 (1). Only one mpl. ; scutellum unspotted ; back of mesonotum without lateral black spots ... ... *manengubae*, Speis.

1. Craspedoxantha marginalis, Wiedemann, 1830.

Three male specimens from Durban Botanical Gardens, v. 1903 (*F. Muir*), numerous specimens of both sexes from Nyasaland, Cholo, x. 1909, and Limbe, 4,000 ft., 22. ix. 1916, " at flowers of mango " (*R. C. Wood*).

The Durban specimens are typical ; Wiedemann had only the female ; to his description may be added : Occiput and frons not spotted, even the ocellar dot being of same colour as the surrounding parts. Lunula broad, yellowish. Peristomialia as broad as the third antennal joint, unspotted. Antennae as long as the face, entirely yellowish ; third joint obtuse at end, with bare arista. Proboscis and palpi yellowish. All the cephalic bristles yellowish, even the rather numerous ocp. ; pvt. and oc. long ; three i. or. Thorax yellowish, but on the back there are four longitudinal blackish stripes, the two middle ones abbreviated behind and fused together, the lateral ones extending to the p. sa. The pleurae have some blackish grey spots, one broader and triangular on lower part of sternopleura. The black rounded spots are as follows : four on the back, disposed as a square between prsc. and dc. ; two pairs at the sides, one just behind the prst., the other before root of wing, near the a. sa. ; there are, moreover, two small black dots on the postalar calli. The two approximated scutellar black spots are placed at the insertion of the a. sc. All the bristles are yellowish ; dc. on the line of the a. sa., and not much exterior to the line of the prsc. ; scp. not developed ; two mpl. Postscutellum and mesophragma blackish grey. The abdomen has a narrow black band at base of the fourth segment ; the two black discoidal spots of the third segment are usually concealed below the preceding segment ; the two apical black spots of the last segment are well distinguishable ; bristles yellowish ; genitalia prominent and yellow ; venter yellow, unspotted. Wings as described by Wiedemann ; second vein straight and long ; submarginal cell narrow ; third vein sometimes with a few bristles in the middle near the small cross-vein and curved downwards before the end, the first posterior cell being thus narrowed outwardly ; small cross-vein beyond the middle of the discoidal cell ; hind cross-vein straight.

The specimen from Cholo is a little atypical, having the back of mesonotum almost entirely yellowish with less distinct dark stripes, indicated only by a black spot in the scapular region, extended behind to the suture.

2. Craspedoxantha unimaculata, Bezzi, Ann. S. Afr. Mus. xix, p. 505, 1924.

A recently described South African variety of the preceding.

3. Craspedoxantha polyspila, Bezzi, *l.c.*, 1924.

A recently described species from South Africa.

45. Terellia, Robineau-Desvoidy, 1830.

The species are as follows :—

1 (4). Wings with dark bands or spots (*Sitarea*, R.D.).
2 (3). Antennae and legs blackish ; bristles of head and thorax black ; wings with two forked dark bands, but without isolated dark spots *hysia*, Walk.
3 (2). Antennae and legs entirely pale yellowish ; bristles yellowish ; wings with two unforked bands and with some isolated dark spots ; scutellum yellowish, black-spotted ... ... *taeniaptera*, Bezzi.
4 (1). Wings quite hyaline, unspotted (*Terellia*, *s. str.*) ; head, antennae, bristles and legs yellowish ; scutellum yellowish, unspotted *australis*, Bezzi.

1. Terellia taeniaptera, Bezzi, Ann. S. Afr. Mus. xix, p. 506, 1924.

A recently described species from South Africa, also found in East Africa.

2. Terellia australis, Bezzi, *op. cit.*, p. 508, 1924.

A recently described South African variety of the Egyptian *planiscutellata*, Becker.

(*To be continued.*)

COLLECTIONS RECEIVED.

The following collections were received by the Imperial Bureau of Entomology between 1st January and 31st March, 1924, and the thanks of the Managing Committee are tendered to the contributors for their kind assistance :—

Dr. Anastasi Alfaro :—4 Orthoptera ; from Costa Rica.

Mr. T. J. Anderson, Government Entomologist :—2 Coccinellidae and 31 Formicidae ; from Kenya Colony.

Mr. Georges Antelme :—3 Tabanidae, 2 Hippoboscidae, 4 other Diptera, 685 Coleoptera, 2 Coleopterous larvae, 13 Hymenoptera, 212 Lepidoptera, 68 Rhynchota, 11 Orthoptera, 2 *Chrysopa*, 5 Odonata, 2 Ticks, and 3 Spiders ; from Mauritius.

Dr. C. F. C. Beeson, Forest Zoologist :—13 Coleoptera, 37 Moths, and 337 Orthoptera : from Dehra Dun.

Mr. G. Bey-Brenko :—9 Orthoptera ; from Serbia.

Drs. H. S. de Boer and V. G. L. van Someren :—94 Culicidae ; from Kenya Colony.

Prof. V. Boldyrev :—4 Orthoptera ; from Russia.

Dr. G. Bondar :—27 Coleoptera, and 344 Rhynchota ; from Brazil.

Mr. J. H. Burkill :—1 species of Coccidae ; from Straits Settlements.

Mr. G. S. Cotterell :—10 Chalcididae ; from the Gold Coast.

Mr. E. Cresswell-George :—16 Coleoptera and 6 early stages ; from Nyasaland.

Dr. A. Cros :—20 Orthoptera ; from Algeria.

Mr. M. T. Dawe :—32 slides of Coccidae and Mites, and examples of Coffee leaves attacked by them ; from Sierra Leone.

Director of Veterinary Education and Research, Pretoria :—94 Siphonaptera ; from South Africa.

Division of Entomology, Pretoria :—35 Coleoptera and 4 Rhynchota ; from South Africa.

Dominion Entomologist, Department of Agriculture, Ottawa :—175 Orthoptera ; from Canada.

Mr. T. Bainbrigge Fletcher, Imperial Entomologist :—5 Moths and 166 Orthoptera ; from India.

Mr. P. v. d. Goot :—4 Diptera, 7 Coleoptera, 6 Lepidoptera, and 9 Rhynchota ; from Java.

Mr. C. C. Gowdey, Government Entomologist :—10 Culicidae, 4 Tabanidae, 122 other Diptera, 173 Coleoptera, 159 Hymenoptera, 11 Lepidoptera, 20 Psyllid pupae, 35 other Rhynchota, 8 Isoptera, 6 Orthoptera, 4 Odonata, and 6 Mites ; from Jamaica.

Mr. G. M. Henry, Colombo Museum :—231 Orthoptera ; from Ceylon.

Mr. G. F. Hill :—137 Isoptera ; from Australia.

Major R. W. G. Hingston :—116 Orthoptera ; from Iraq.

Dr. W. Horn :—193 Coleoptera ; from Africa.

Mr. M. Afzal Hussain, Government Entomologist :—63 Siphonaptera, 100 Anoplura, and 4 Mites ; from Punjab, India.

Mr. F. P. Jepson :—21 Coleoptera ; from Ceylon.

Dr. W. B. Johnson :—6 Tabanidae, 3 other Diptera and 13 pupa cases, 3 Chalcids, 7 Lepidopterous pupae, 95 Ticks, 2 Toads, and 2 Lizards ; from Northern Nigeria.

Mr. L. Kalshoven, Forest Entomologist :—111 Curculionidae and 11 early stages ; from Java.

Mr. C. R. Kellogg :—294 Coleoptera ; from China.

Dr. I. J. Kligler :—13 Culicidae, 15 other Diptera, and 3 Hymenoptera ; from Palestine.

Mr. E. Boden Kloss :—266 Orthoptera ; from Straits Settlements.

Dr. W. A. Lamborn, Medical Entomologist :—63 Culicidae, 3 Tabanidae, 2 other Diptera and 2 pupa cases, 3 Moths and 2 pupae ; from Nyasaland.

Mr. S. F. Light :—320 Coleoptera and 5 larvae, 5 Orthoptera, and 2 Spiders ; from China.

Mr. G. A. Mavromoustakis :—23 Diptera and 33 Hymenoptera ; from Cyprus.

Mr. D. Miller, Government Entomologist :—23 Curculionidae ; from New Zealand.

Mr. N. C. E. Miller :—161 Orthoptera ; from Tanganyika Territory.

Museum National d'Histoire Naturelle, Paris :—494 Orthoptera ; from North Africa.

Natal Museum, Pietermaritzburg :—1,225 Coleoptera ; from South Africa.

Dr. S. A. Neave :—7 Culicidae, 14 other Diptera, 42 Coleoptera, 13 Hymenoptera, 76 Lepidoptera, 12 Rhynchota, 16 Orthoptera, and 3 Odonata ; from Trinidad, British West Indies.

Prof. G. H. F. Nuttall, F.R.S. :—18 Hippoboscidae ; from Palestine.

Mr. L. Ogilvie, Plant Pathologist, Department of Agriculture :—7 Coleoptera, 5 Hymenoptera and 3 cocoons, 8 species of Coccidae, 47 other Rhynchota, and a number of Mites ; from Bermuda.

Mr. A. W. J. Pomeroy, Government Entomologist :—5 Diptera, 6 Coleoptera, and 32 Lepidoptera ; from Southern Nigeria.

Mr. J. Reed :—2 species of Coccidae ; from the Canary Islands.

Mr. A. H. Ritchie, Government Entomologist :—43 Diptera and 16 pupa-cases, 424 Coleoptera and early stages, 19 Hymenoptera, and 5 Lepidoptera ; from Tanganyika Territory.

Mr. H. W. Simmonds :—3 Diptera, 2 Coleoptera, and 4 Chalcididae ; from the New Hebrides.

Mr. E. R. Speyer :—358 Coleoptera and 300 Collembola ; from Cheshunt, Herts.

Mr. C. F. M. Swynnerton :—20 Diptera, 829 Coleoptera, 40 Hymenoptera, 287 Rhynchota, 204 Orthoptera, and 6 Scorpions ; from Tanganyika Territory.

Mr. A. Thery :—23 Orthoptera ; from Morocco, North Africa.

Mr. H. P. Thomasset :—14 Culicidae, 2 *Phlebotomus*, 13 Tabanidae, 7 Simuliidae, 8 *Auchmeromyia*, 4 Psychodidae, 738 other Diptera, 360 Coleoptera, 213 Hymenoptera, 380 Lepidoptera, 10 Aphididae, 211 other Rhynchota, 13 Orthoptera, 29 Trichoptera, 6 *Chrysopa*, and 12 Ephemeridae ; from Natal.

Mr. R. Veitch :—208 Diptera, 9 Coleoptera, 20 Hymenoptera, 19 Lepidoptera, 2 Rhynchota, and 2 Orthoptera ; from Fiji Islands.

Wellcome Tropical Research Laboratories :—164 Diptera, 118 Coleoptera, and 7 Hymenoptera ; from British Sudan.

Mr. D. S. Wilkinson, Government Entomologist :—10 Diptera, 18 Coleoptera, and 28 Chalcididae ; from Cyprus.

Mr. C. L. Withycombe :—22 Culicidae, 23 other Diptera and 6 pupa-cases, 3 Chalcids, 16 Rhynchota, 3 Spiders, and 4 tubes containing a large number of minute insects ; from Trinidad, British West Indies.

Mr. G. N. Wolcott :—10 Curculionidae ; from Porto Rico.

Dr. W. A. Young :—9 Ticks ; from the Gold Coast.

FURTHER NOTES ON THE ETHIOPIAN FRUIT-FLIES, WITH KEYS TO ALL THE KNOWN GENERA AND SPECIES.—(*Cont.*).

By Prof. M. Bezzi,
Turin, Italy.

46. **Brachyaciura,** gen. nov.

In the form of the head this genus is allied to the *Acidia-Pseudospheniscus* group, but is distinguished by the very short antennae, by the bare third vein, by the dc. bristles being placed on the line of the a. sa., by the peculiar coloration of the head, and by the wing-pattern of the *Aciura* type. Only one as yet undescribed species from Abyssinia, *Br. kovácsi*, Bezzi.

47. **Rhynchoedaspis,** Bezzi, 1924.*

This recently described genus (Ann. S. Afr. Mus. xix, p. 508, 1924) is the first representative of the group associated with *Oedaspis* in the Ethiopian Region, and differs from the usual forms in the proboscis, being otherwise typical, even in wing-pattern.

1. Rhynchoedaspis munroana, Bezzi, 1924.

A recently described species (*op. cit.* p. 509, 1924), easily recognizable by the long, bicubitate proboscis.

The type is from the Transvaal; there is in the British Museum a male, in poor condition, from Portuguese East Africa, Port Amelia, 1914, "found in clutches of big black beetle, probably its food" (*F. V. Best*). Numerous specimens of both sexes from Nyasaland, Ruo, 5. v. 1916 (*R. C. Wood*).

48. **Munroella,** Bezzi, 1924.

A recently described genus near *Spheniscomyia*, with the two cross-veins placed in a straight line.

1. Munroella myiopitina, Bezzi, 1924.

A recently described species (Ann. S. Afr. Mus. xix, p. 511, 1924), easily distinguishable by the *Myiopites*-like wing-pattern, and by the shining black body.

Numerous specimens of both sexes from Nyasaland, Ruo, 6. v. 1916 (*R. C. Wood*).

49. **Aciura,** Robineau-Desvoidy, 1830.

After long hesitation and study I have decided to include in the present genus only species which show the typical wing-pattern, placing the others in *Spheniscomyia*, and those with a densely grey-tomentose mesonotum in *Tephrella*.

The Ethiopian species are as follows :—

1 (18). All the bristles of the occipital border whitish.
2 (9). Scutellum with four bristles ; halteres black.

* Prof. Bezzi writes that this generic name falls as a synonym of *Oedoncus*, Speiser, Beitr. aus d. Tierk., Widmungschr. für Prof. Dr. M. Braun, Königsberg, p. 154, Juli 1924; and the species *Rh. munroana*, Bezzi, is also a synonym of *Oe. taenipalpis*, Speiser, *op. cit.* p. 155, fig. p. 156.

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3 (4). The hyaline base of wing has a short black stripe along the fore border, which does not extend beyond the humeral cross-vein *caeca*, Bezzi.
4 (3). There is a broad black marginal stripe in both the costal cells, extending from the base to the stigma.
5 (8). The three hyaline indentations of the hind border of wing are narrow as usual, and all stop at the 5th vein, without entering the discoidal cell.
6 (7). Femora mainly black, ovipositor longer than the abdomen *tetrachaeta*, Bezzi.
7 (6). Femora and coxae entirely reddish ; ovipositor as long as the abdomen *haematopoda*, Bezzi.
8 (5). The above-named indentations are broader, chiefly that of the second posterior cell, which is twice as broad as usual, and moreover the two basal ones extend into the discoidal cell ... ... *latincisa*, sp. nov.
9 (2). Scutellum with two bristles only ; halteres whitish.
10 (13). Wings quite cuneiform, with a very narrow base and with a rudimentary axillary cell ; in the hyaline base of wing there is an isolated oblique dark band, extending from fore to hind border.
11 (12). No hyaline spot in the first posterior cell ... ... *angusta*, Loew.
12 (11). A hyaline rounded spot in the base of the first posterior cell. *sphenoptera*, sp. nov.
13 (10). Wings not cuneiform, with more developed axillary cell and without any isolated basal dark band.
14 (17). Wings elongate, with a marginal dark basal stripe, which ends before the stigma.
15 (16). No hyaline spot in the first posterior cell ; axillary cell rather narrow *semiangusta*, Bezzi.
16 (15). A hyaline rounded spot in the first posterior cell ; axillary cell normal *oborinia*, Walk.
17 (14). Wings short, with only a black basal spot at the extreme root *basimacula*, sp. nov.
18 (1). All the bristles of the occipital border black.
19 (22). Scutellum with four bristles, halteres black, wings without hyaline discal spots and with a complete costal black stripe at base.
20 (21). Wings short, with the hyaline indentations of fore border narrow and linear, and those of hind border narrowed outwardly ; ovipositor very short... ... ... *grandidieri*, Bezzi.
21 (20). Wings elongate, with the hyaline indentations of fore border broad and triangular as usual, ovipositor as long as the body *nigriseta*, Bezzi.
22 (19). Scutellum with two bristles only, wings with hyaline discal spots and with the costal basal stripe wanting or incomplete.
23 (24). Wings narrow and long, without dark basal stripe at costa and with two hyaline spots, one of which is in the discoidal cell *perspicillaris*, Bezzi.
24 (23). Wings of usual shape, with incomplete black basal stripe and with three hyaline spots, two of which are in the discoidal cell *tibialis*, R.D.

1. Aciura haematopoda, Bezzi, Ann. S. Afr. Mus. xix, p. 512, 1924.

A recently described form of *tetrachaeta*, distinguished by the entirely red legs, only the hind tibiae being more or less darkened.

A male specimen from British Sudan, Tokar, 1917 (*H. W. Bedford*). This specimen differs from the typical South African ones in having all the bristles of the thorax and scutellum pale yellowish (instead of black or dark brownish).

2. Aciura latincisa, sp. nov.

This species, from East Africa, will be more fully described elsewhere.

3. Aciura sphenoptera, sp. nov.

Likewise an East African species, to be fully described later.

4. Aciura oborinia, Walker, 1849.

One male specimen from Nyasaland, Cholo, 23. v. 1916 (*R. C. Wood*).

5. Aciura basimacula, sp. nov.

Nearly allied to *grandidieri*, Bezzi, both in wing form and wing-pattern, but distinguished in having a broad basal dark spot at root of wing in place of the usual dark marginal stripe ; moreover, the ocp. are all yellowish instead of black.

♂. Length of body 4 mm. ; of wing 3·5 mm.

Occiput black, dark grey-dusted. Frons twice as long as broad, dark yellowish, reddish in front, with narrow greyish sides and middle stripe ; lunula whitish. The very narrow face and the linear parafacialia and peristomialia are whitish, the latter quite unspotted. Antennae entirely reddish, shorter than the face, with bare arista. Palpi and proboscis pale yellowish. Pvt., outer vt. and ocp. all whitish ; inner vt. and or. dark brownish ; three i. or. Thorax entirely black, unspotted, with faint dark grey dust on back and thus rather shining ; the short pubescence of back is pale yellowish ; bristles dark yellowish or brownish. Scutellum with only the basal pair of bristles, which are very long. Halteres whitish. Abdomen entirely black, with dark pubescence and blackish bristles ; venter likewise black. Legs with blackish coxae and femora ; the ends of the latter, the tibiae and the tarsi reddish, but the hind tibiae darkened. Wings short and broad, rounded outwardly, with normally developed axillary cell. No costal bristle. Wings black, with hyaline base and five hyaline indentations. In the hyaline base there is a black triangular spot at the extreme root, extending from the base of the second costal cell to the base of the anal cell. The two hyaline indentations of the fore border are rather narrow, the inner with its point on third vein, the outer one with its point on fourth vein. The three hyaline indentations of hind border are very narrow, oblique, and all parallel ; the middle one is the smallest and ends at fifth vein, while the basal one has its upper corner extended into the discoidal cell.

Type ♂, and an additional specimen of the same sex from Minikoi, Laccadive Is., 20. vi. 1900 (*Gardiner*).

6. Aciura grandidieri, Bezzi, 1924.

A recently described species from Madagascar (Bull. Mus. Hist. Nat., Paris, xxx, p. 88, 1924).

7. Aciura nigriseta, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 513, 1924).

50. Spheniscomyia, Bezzi, 1913.

I have decided to include in the present genus certain species formerly placed in *Aciura* (*capensis*, *binaria* and *ternaria*), which have not the typical wing-pattern with the two hyaline indentations on the fore border and the three on the hind border,

Therefore we have now in the genus species with four and species with two scutellar bristles; and species with black ocp. and species with whitish ocp. (genus? *Metasphenisca*, Hendel); *caloptera*, Loew, is also to be placed here, while *winnertzi* and *alacris* have a peculiar wing-pattern.

The species are as follows:—

1 (12). All the bristles of the occipital border black.

2 (7). Scutellum with four bristles.

3 (4). Wings with but a single hyaline indentation on fore border; the four hyaline indentations on hind border broad and not disposed in pairs *sexmaculata*, Macq.

4 (3). Wings with two approximated hyaline indentations on fore border; the four posterior indentations shorter and paired.

5 (6). Three rounded hyaline spots in the middle of wing; the external posterior indentation not longer than the anterior one, and ending at fourth vein *ternaria*, Loew.

6 (5). No hyaline discal spots; the external posterior indentation longer, extending into the submarginal cell ... ... *capensis*, Rond.

7 (2). Scutellum with only the basal pair of bristles.

8 (9). Halteres black; only one hyaline indentation on fore border and only two on hind border; three hyaline discal spots; base of wing black *compacta*, Bezzi.

9 (8). Halteres whitish; two hyaline indentations or spots on fore border, and four or more on hind border; one or two hyaline discal spots; base of wing hyaline.

10 (11). Wings with two regular hyaline indentations on fore border; and four paired indentations on hind border; only one hyaline spot on the base of discoidal cell ... ... *neavei*, Bezzi.

11 (10). Two irregular hyaline spots on fore border; hind border entirely hyaline, with a single (or rarely with two) fuscous rays reaching hind margin of wing; two hyaline discal spots, the second at the base of the first posterior cell ... ... *binaria*, Loew.

12 (1). Bristles of the occipital border whitish (*Metasphenisca*, Hend.); scutellum with two bristles only; halters whitish; fore border with two hyaline irregular spots or indentations; hind border hyaline, with three fuscous rays; base of wing always hyaline.

13 (16). Femora black; second hyaline indentation of fore border reduced to a small spot, which does not extend beyond the second longitudinal vein.

14 (15). The hyaline indentations on hind border long and broad, and fused with the hyaline spots at the base of first posterior cell and in the discoidal cell; first posterior cell typically with two hyaline spots *quaternaria*, Bezzi.

15 (14). Hyaline indentations on hind border not fused with the hyaline spots, except that at end of discoidal cell; first posterior cell with a single basal hyaline spot ... ... *senaria*, sp. nov.

16 (13). Femora entirely yellow; the second hyaline indentation on fore border about as long as the first; first posterior cell with two hyaline spots *quinaria*, Bezzi.

1. Spheniscomyia compacta, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 515, 1924).

2. Spheniscomyia neavei, Bezzi, 1920.

A couple of specimens from Nyasaland, Cholo, x. 1919 (*R. C. Wood*).

3. Spheniscomyia binaria, Loew, 1861.

Two female specimens from Nyasaland, Cholo, xi. 1919 (*R. C. Wood*). The species is widely spread over the entire Ethiopian Region, from the Cape to Abyssinia.

4. Spheniscomyia quarternaria, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 516, 1924).

5. Spheniscomyia senaria, sp. nov.

A species from Uganda that will be more fully described elsewhere.

6. Spheniscomyia quinaria, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 517, 1924).

51. Tephrella, Bezzi, 1913.

This genus is here used in a somewhat different sense from that in my previous papers; it is difficult to distinguish the species from those of *Spathulina*. With the exclusion of *hessii*, all the species here recorded are homogeneous, having all whitish ocp., four sct. and a closer wing-pattern, without a terminal hyaline spot. They are as follows :—

1 (6). Second posterior cell with only one hyaline indentation.

2 (5). Apical half of the submarginal cell entirely black, without a hyaline spot; costal cells margined with black.

3 (4). The second hyaline indentation of the fore border not united with the middle indentation on the hind border ... ... *bezziana*, End.

4 (3). The second hyaline indentation united with the middle one, thus forming a single hyaline band in the middle of the wing extending from the fore to the hind border ... ... *nigricosta*, Bezzi.

5 (2). Apical half of the submarginal cell with a broad hyaline spot just before the end of the second longitudinal vein; costal cells not margined with black *cyclopica*, Bezzi.

6 (1). Second posterior cell with two hyaline indentations, or with a second broad hyaline spot, or with several hyaline spots, or almost entirely hyaline with an isolated dark spot.

7 (8). Second posterior cell quite hyaline, with an isolated fuscous spot at hind border; in the male the two hyaline indentations on fore border are fused together; femora black ... ... *dispar*, Bezzi.

8 (7). Second posterior cell without such a pattern and with the usual hyaline indentations; the two hyaline indentations on fore border usually well separated in both sexes.

9 (12). Femora black.

10 (11). Third posterior cell with a single but very long hyaline indentation; the two hyaline indentations on fore border not separated in the marginal cell; no hyaline spots in the middle of wing *tephronota*, Bezzi.

11 (10). Third posterior cell with two short hyaline indentations ; hyaline indentations on fore border well separated ; three rounded hyaline discal spots ... ... *katonae*, sp. nov.

12 (9). Femora orange ; third posterior cell with two hyaline indentations, or with a second hyaline spot, or with several hyaline spots ; the indentations on fore border regularly separated.

13 (14). Costal cells with a marginal black stripe ; no hyaline spots in middle of wing ; the external indentation of the second posterior cell is reduced to a marginal spot united with the internal one ... ... *limbata*, sp. nov.

14 (13). Costal cells entirely hyaline, not margined with black.

15 (18). Abdomen red.

16 (17). Second posterior cell with only the basal hyaline indentation, the external one being reduced to a rounded spot near the wing-border ; discoidal cell entirely black ... ... *rufiventris*, Bezzi.

17 (16). Second posterior cell with two indentations and moreover with three hyaline spots near the fourth vein ; discoidal cell with two hyaline spots *polyspila*, sp. nov.

18 (15). Abdomen black ; second posterior cell with two hyaline indentations, the anterior of which is prolonged above into the first posterior cell.

19 (20). No hyaline spots in the discoidal cell ... ... *sexfissata*, Beck.

20 (19). Discoidal cell with two rounded hyaline spots.

21 (22). The two hyaline indentations in the third posterior cell do not extend into the discoidal cell, the two hyaline spots in which remain therefore isolated *distigma*, Bezzi.

22 (21). The above-named indentations with their inner corners produced into the discoidal cell and thus fused with the hyaline spots, at least the internal one ... ... *erosa*, sp. nov.

1. Tephrella katonae, sp. nov.

A species from East Africa.

2. Tephrella limbata, sp. nov.

A species from Uganda. These two species will be fully described later.

3. Tephrella cyclopica, Bezzi, 1908.

A couple of specimens from British Sudan, Khartoum, vii. 1908 (*H. H. King*).

4. Tephrella dispar, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 518, 1924).

5. Tephrella rufiventris, Bezzi, 1918.

One female specimen from British Sudan, Tokar, 1912 (*H. W. Bedford*).

This specimen agrees perfectly with my type from Eritrea.

6. Tephrella polyspila, sp. nov.

A species from East Africa.

7. Tephrella erosa, sp. nov.

Another East African species. These two species will be more fully described later.

8. Tephrella distigma, Bezzi, 1924.

Of this recently described (Ann. S. Afr. Mus. xix. p. 519, 1924) South African species there are some specimens of both sexes from Mashonaland, Salisbury (*G. A. K. Marshall*). It is a widely distributed species.

Subfam. IV. TRYPANEINAE.

52. Platomma, Bezzi, 1924.

This recently described genus (Ann. S. Afr. Mus, xix, p. 526, 1924) was erected for *Trypeta lunifera*, Loew, 1861, from the Cape, on account of its very peculiar head and general shape.

53. Elaphromyia, Bigot, 1859.

An important character of the present genus is the peculiar nature of the ocp.; there are two or three whitish and longer bristles, rather stout and obtuse, placed at a great distance apart, and these have induced me to place the genus in the TRYPANEINAE; but towards the middle of the occipital border there is a row of short, stout black bristles, which were overlooked by me in 1913, when describing my genus *Paralleloptera*. Owing to this last character, the present genus may perhaps be better placed in the CERATITINAE near *Ocnerioxa*, with which it agrees in some particulars.

1. Elaphromyia adatha, Walker, 1849.

It seems that in the Ethiopian Region there is only this single widely-spread species; it is very like the Oriental *pterocallaeformis*, Bezzi, which ranges from India to the Philippines and Formosa. The coloration of this fly is very curious; the last abdominal segment bears two rounded black spots, one on each side, more distinct in the male than in the female; the male has, moreover, a third black spot at base of the genitalia.

Numerous specimens of both sexes from Nyasaland, Cholo, 4. ix. 1919 (*R. C. Wood*); one female from East Africa, Moschi, 3. v. 1916 (*Dr. W. A. Lamborn*).

54. Platensina, Enderlein, 1911.

1. Platensina diaphasis, Bigot, 1891.

Of this West African species, the only one at present known from the Ethiopian Region, there is a female specimen from Zanzibar, 15. viii. 1916, "on orange leaves" (*Dr. W. M. Aders*).

55. Afreutreta, Bezzi, 1924.

Having recognised that *Eutretosoma*, Hendel, belongs to the SCHISTOPTERINAE, a new name is necessary for the species formerly placed by me under that name, and therefore I have proposed the above one (Ann. S. Afr. Mus. xix, p. 527, 1924).

The species of the present genus may or may not have dilated wings; and the black spots on the face and frons may be present or absent. It is possible that even

polygramma, Walk., on account of its characteristic pattern, may belong also to the SCHISTOPTERINAE. The known species are as follows; as type of the genus I select *Trypeta bipunctata*, Loew, 1861.

1 (6). Wings distinctly dilated, with the second basal cell broadened; frons with black spots at root of antennae.
2 (5). Wings with exceedingly numerous hyaline dots on the disc; stigma with some hyaline spots.
3 (4). First posterior cell black at end; wings without deep black spots on disc; stigma with four hyaline spots in the middle *frauenfeldi*, Schin.
4 (3). First posterior cell with a hyaline border at end; wings with some deep black spots on disc; stigma with only two hyaline marginal spots and none in middle ... ... *millepunctata*, Bezzi.
5 (2). Wings with less numerous hyaline spots, but with a broad, yellowish, unspotted patch in the middle; stigma quite black, unspotted; abdomen entirely red ... ... *discoidalis*, Bezzi.
6 (1). Wings not dilated, with normal second basal cell.
7 (8). Frons with black spots at root of antennae; first posterior cell hyaline at end; marginal cell with a hyaline streak at costa beyond the stigma; hyaline spots much more numerous, being disposed in three rows in the middle cells ... ... *bipunctata*, Loew.
8 (7). Frons without such black spots; first posterior cell black at end; marginal cell quite black along the costa; hyaline spots less numerous and disposed in two rows only ... ... *biseriata*, sp. nov.

1. Afreutreta discoidalis, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 528, 1924).

2. Afreutreta biseriata, sp. nov.

A species with undilated wings, nearly allied to *bipunctata*, Loew, but with a different, less mottled wing-pattern.

♂. Length of body 4 mm.; of wing 4 mm.

Occiput black, grey-dusted, yellowish on vertex and at eye-borders and more broadly so on the lower part. Frons $1\frac{1}{2}$ times as long as broad, reddish, with greyish sides and with an elongate grey ocellar triangle in which there is the black ocellar dot; no black spots in front; lunula whitish. Face yellowish, whitish-dusted; peristomialia narrower than the third antennal joint, whitish, unspotted. Antennae entirely of a pale yellowish colour, a little shorter than the face. Proboscis short and yellowish, like the palpi. Ocp. whitish and not very thick; frontal bristles yellow; 3 i. or. Thorax entirely black, opaque, with dark reddish humeri and root of wings; on the back it is clothed with dark grey dust and yellowish pubescence; bristles black, dc. placed in a line with the a. sa.; 4 sct. Scutellum triangular, flat, coloured like back of mesonotum, dark reddish at hind border. Calypters dirty whitish; halteres yellowish. Abdomen entirely black, dark grey-dusted, a little shining, with dark yellowish pubescence. Legs yellow, with more or less blackened coxae and femora. Wings of usual shape, as long as the body; costal bristle short; stigma black, elongate, but shorter than the second costal cell; second vein straight, last portions of third and fourth veins perfectly straight and parallel; third vein bare; second basal cell not dilated; small cross-vein placed after the middle of the discoidal cell, at a distance from the hind cross-vein, about as long as the latter, or a little longer; lower angle of the anal cell acute and a little produced. The wings are entirely black, only the axillary lobe and the alula being paler. The costal and marginal cells are unspotted, the latter with only two small dots in the middle along

the second longitudinal vein. Submarginal, first basal, first posterior, discoidal and third posterior cells, all with two more or less regular rows of small, rounded, yellowish-subhyaline dots. Along the wing-border there are some rounded, broader and whitish-hyaline dots, and particularly one a little before end of the marginal cell, one before end of the submarginal, four of equal size and at equal distances in the second posterior cell, and three a little smaller in the third posterior cell. First posterior cell entirely black at end.

Type ♂, and another not well-preserved specimen from Chirinda Forest, x. 1905 (*G. A. K. Marshall*).

56. **Euaresta,** Loew, 1873.

The known species are as follows :—

1 (4). Scutellum with two bristles only.
2 (3). Abdomen reddish yellow, with a black terminal segment ; discoidal and third posterior cells mainly hyaline, the wing-pattern being *Trypanea*-like .... *amplifrons*, Bezzi.
3 (2). Abdomen blackish grey, with reddish hind borders to the segments ; wings with a different pattern, the discoidal and third posterior cells mainly dark ... ... *lunifrons*, Bezzi.
4 (1). Scutellum with four bristles ; abdomen blackish grey; wings with the discoidal cell black, with a few hyaline spots, but with the third posterior cell mainly hyaline ... ... *planifrons*, Loew.

1. Euaresta lunifrons, Bezzi, 1924.

A recently described South African species (Ann. S. Afr. Mus. xix, p. 530, 1924).

57. **Pliomelaena,** Bezzi, 1918.

It is not always easy to separate the species here grouped from those of *Platensina*, but they have the wings always narrower ; moreover, the species with a bristly third longitudinal vein are closely allied to those of the genus *Xyphosia*, being distinguishable only by the ocp.

The species are as follows :—

1 (8). Frons as broad as or broader than one eye ; halteres with whitish knob ; arista nearly bare ; first posterior cell with two hyaline dots besides the apical hyaline spot ; discoidal cell with two hyaline spots ; second posterior cell with four broad hyaline spots.
2 (7). Third longitudinal vein bare, as usual, or with only a few scattered bristles at base ; discoidal cell with small basal hyaline spot.
3 (6). Stigma with yellowish spot.
4 (5). Abdomen entirely shining black in both sexes... ... *brevifrons*, Bezzi.
5 (4). Abdomen in both sexes mainly reddish, or at least with broad red hind borders to the segments ... ... var. *rufiventris*, Bezzi.
6 (3). Stigma unspotted ... ... *aspila*, var. nov.
7 (2). Third vein bristly to beyond the small cross-vein ; discoidal cell with a broad hyaline basal patch ... ... *xyphosiina*, sp. nov.
8 (1). Frons narrower than one eye ; halteres with blackish knob.
9 (10). No terminal hyaline spot at end of first posterior cell ; second posterior cell with three rather broad hyaline spots ; arista nearly bare ; third vein bristly ... ... *caeca*, sp. nov.
10 (9). First posterior cell with terminal hyaline spot ; second posterior cell with 2–3 small hyaline spots ; arista with rather long pubescence.

11 (12). Stigma blackish, with a single hyaline spot at base ; marginal cell with only two hyaline spots or indentations ... ... *strictifrons*, Bezzi.

12 (11). Stigma yellowish, with two hyaline spots ; marginal cell with numerous hyaline spots or indentations.

13 (14). Marginal cell with 6–7 hyaline spots and indentations ; first posterior and discoidal cell each with only one hyaline dot ; second posterior cell with one hyaline dot at upper internal corner *stigmatica*, Bezzi.

14 (13). Marginal cell with 12–14 such spots ; second posterior cell without hyaline dot.

15 (16). Discoidal and first posterior cell with some hyaline dots ; submarginal cell with numerous hyaline spots ; third vein bare *woodi*, sp. nov.

16 (15). The above-named cell without hyaline dots, except that at end of first posterior cell ; submarginal cell with only 2–3 spots, third vein bristly *guttatolimbata*, End.

1. Pliomelaena brevifrons, Bezzi, var. **rufiventris**, Bezzi, 1924.

Of this recently described (Ann. S. Afr. Mus. xix, p. 532, 1924) South African form there are two females from Nyasaland, Cholo, xi. 1919 (*R.C. Wood*). They differ in having the basal hyaline spot of the discoidal cell small and quite isolated, while in typical specimens this spot is much broader, and more or less fused with the hyaline spot of the third posterior cell ; moreover, in the female the abdomen is almost entirely red.

2. Pliomelaena brevifrons, Bezzi, var. **aspila,** nov.

Differs from the preceding in having the pterostigma entirely black, unspotted ; the abdomen shows the same coloration. The hyaline spots of second and third posterior cells are fused together to form a complete hyaline indentation.

Lengths of body and wing 4 mm.

Type ♂, a single specimen from Nyasaland, Ruo, 200 ft., 8. vi. 1916 (*R. C. Wood*).

3. Pliomelaena xyphosiina, sp. nov.

A species from Abyssinia that will be more fully described later.

4. Pliomelaena caeca, sp. nov.

Provisionally placed in the present genus and nearly allied to *xyphosiina*, Bezzi, but at once distinguishable from it, as well as from any other species at present known, by the lack of the hyaline apical spot of the wings.

♂. Length of body 4·2 mm. ; of a wing 4·5 mm.

Occiput yellowish, opaque grey-dusted, with a black bilobate spot in middle above the neck. Frons about twice as long as broad, yellowish, opaque, with a blackish ocellar dot ; lunula whitish. Face whitish, very narrow ; peristomialia whitish, narrow, unspotted. Antennae entirely reddish, a little shorter than the face ; third joint rounded at end ; arista with very short pubescence. Mouth-border slightly prominent ; palpi whitish ; proboscis yellowish, short and thick. All the occipital bristles whitish, rather thick, but acute and long ; frontal bristles dark yellowish or blackish ; oc. long ; three i. or. Thorax reddish, clothed with opaque grey dust, and with short dark pubescence ; a complete blackish stripe along the middle, prolonged on the scutellum ; bristles dark yellowish, with blackish base and inserted on small black dots. Scutellum yellowish, with four bristles on small black dots, the apical ones decussate. Mesophragma black, grey-dusted. Calypters whitish ; halteres yellowish, with darkened knob. Abdomen reddish, distinctly shining ; second segment with two small blackish spots in the middle ; third and fourth with two larger blackish spots, occupying almost their whole surface ; genitalia reddish,

with a shining black spot ; pubescence yellowish, rather long ; venter pale yellowish, quite unspotted. Legs entirely yellowish ; front femora with four yellowish bristles below. Wings long, with a distinct costal bristle ; stigma elongate, black, with yellowish base, and with a yellowish rounded spot in the middle of the black part ; 2nd, 3rd and 4th veins straight and diverging somewhat towards the apex ; third vein with distinct short bristles throughout its whole length ; small cross-vein a little beyond middle of discal cell ; hind cross-vein straight ; lower angle of anal cell acute but very little produced. The wing-pattern is in part reticulate, but with three broad fuscous unspotted patches, one of which is below stigma, one at hind cross-vein and one at apex ; this last is the broadest and quite unspotted, with only a small rounded hyaline spot just below the end of the second longitudinal vein. In the middle of wing, between the two fuscous patches, there is one paler indentation, consisting of two broad hyaline spots in the marginal cell, four smaller spots in one row in the submarginal cell, and three in the first posterior cell, the fuscous parts between them being distinctly yellowish. Moreover, the first posterior cell has another rounded hyaline spot; second posterior cell with 3–4 broad hyaline spots, forming a triangle. Discoidal cell broadly hyaline in the middle, forming two incomplete indentations ; third posterior cell broadly hyaline in the middle and at base ; axillary cell slightly infuscated, with 4–5 hyaline spots.

Type ♂, a single specimen from Nyasaland, Limbe, 4,000 ft., 24. ix. 1916, " at flowers of mango " (*R. C. Wood*).

5. Pliomelaena stigmatica, Bezzi, 1924.

A recently described South African species (Ann. S. Afr. Mus. xix, p. 533, 1924).

6. Pliomelaena woodi, sp. nov.

Allied to *stigmatica*, Bezzi, but very distinct on account of its peculiar wing pattern.

♂. Length of body 4·5 mm. ; of wing 5 mm.

Head entirely yellowish, with the occiput blackish, grey-dusted in the middle. Frons narrower than one eye, twice as long as broad, with paler sides ; face pale yellowish, like the very narrow linear peristomialia. Antennae entirely pale yellowish ; arista with rather long pubescence, almost shortly plumose. Palpi and proboscis pale yellowish, the latter short. All the occipital bristles whitish ; the s. or. darker, the three i. or. blackish. Thorax black, clothed with dense, opaque, light grey dust ; humeri, pleural sutures and breast reddish, bristles dark yellowish ; dc. before the line of the a. sa. ; scp. distinct. Scutellum with reddish hind border ; apical sct. as long as the basal. Halteres with blackish knob. Abdomen entirely shining black, with pale pubescence and dark bristles at end. Legs and coxae entirely pale yellowish ; the strong bristles of the front femora dark yellowish. Wings long and broad ; they are yellowish brown with numerous hyaline spots between the third vein and the costa, and blackish brown elsewhere, with scattered hyaline dots, and a row of broader ones along the hind border. Costal cell with a black band in the middle, thus forming two hyaline spots ; stigma yellowish, with two broad hyaline spots. Marginal cell with three broad hyaline spots along the costa, with 9–10 smaller on a line along the second vein ; submarginal cell with 9–10 hyaline spots, and a broader one at end of second vein, with the upper corner continued into the marginal cell. First basal cell with a small hyaline spot just before the small cross-vein. First posterior cell with two hyaline spots near the base, two very small ones in the middle and a larger one at the apex. Discoidal cell with three hyaline spots, all small, the external one placed at the lower outer corner. Second posterior cell unspotted in the middle, with two broad marginal hyaline spots ; third posterior cell with two small hyaline spots on the disc, and six broader ones along the hind border ; axillary lobe black, with one subhyaline spot. Extreme base of

wing hyaline. Second and third veins strongly diverging at end; third and fourth distinctly converging at end; the distance between the cross-veins about equal to the length of the hind cross-vein; third vein bare; lower angle of anal cell acute but short.

Type ♂, a single specimen from Nyasaland, 4. x. 1919 (*R. C. Wood*); named in honour of the collector.

The present species shows an unmistakable affinity in wing-pattern with *guttatolimbata*, End., from Madagascar; but the latter has the lower angle of anal cell more elongate, and, as it seems, a bristly third vein; it was previously placed by me near *Ptiloniola*, but as the ocp. are described as whitish, it may be perhaps better placed here.

58. **Spathulina**, Rondani, 1856.

The very numerous species placed here are not always easily distinguishable from *Tephrella*, chiefly those with 4 sct., and from *Euribia*. A good character separating them from the former is the presence of an apical hyaline spot on the wing, and thus I have now placed here the *Trypeta hessii* of Wiedemann. From *Euribia* they may be distinguished by the rather uncertain character that the markings of the wings are not reticulate. Even the distinction from *Pliomelaena* is not always satisfactory.

1 (16). Scutellum with four bristles, even if the apical pair is sometimes very small.
2 (15). Always three i. or.; legs all orange; abdomen shining black or shining red; wings always with well developed terminal hyaline spot.
3 (8). A. sct. about as long as the b. sct., stigma without hyaline spot; basal hyaline spot of the discoidal cell fused with the terminal spot of the first basal cell to form a single hyaline spot.
4 (5). Second posterior cell with four hyaline spots; abdomen black; bristles pale yellowish ... ... *bioculata*, Bezzi.
5 (4). Second posterior cell with only three hyaline spots.
6 (7). Abdomen entirely black; bristles dark brownish *semiatra*, Loew.
7 (6). Abdomen broadly red at sides, chiefly in the male; bristles pale yellowish var. *semirufa*, Bezzi.
8 (3). A. sct. much smaller than the b. sct.; stigma with hyaline spot at base; first basal cell usually without hyaline terminal spot, the basal hyaline spot of the discoidal cell being thus isolated.
9 (10). First basal cell with isolated terminal hyaline spot; first posterior cell with four broad hyaline spots ... ... *aldabrensis*, Lamb.
10 (9). First basal cell not spotted at end; first posterior cell with more numerous hyaline spots or with hyaline indentations.
11 (14). Second posterior cell with five separated hyaline spots.
12 (13). Discoidal cell with three hyaline spots; first posterior cell in the middle with two hyaline dots, one above the other, besides the basal and apical hyaline spots ... ... *margaritifera*, Bezzi.
13 (12). Discoidal cell with only two hyaline spots; first posterior cell with only one hyaline spot in the middle ... ... *munroi*, Bezzi.
14 (11). Second posterior cell with three elongated hyaline indentations; discoidal cell with two hyaline spots; first posterior cell with only one hyaline spot in the middle ... ... var. *majuscula*, Bezzi.
15 (2). Only two i. or.; legs with black femora; abdomen densely grey-dusted; wings with no terminal hyaline spot; scutellum with four bristles, the apical pair smaller; stigma unspotted ... *anomalina*, Bezzi.
16 (1). Scutellum with only two bristles, the apical pair being quite wanting; only two i. or.; stigma always unspotted.
17 (20). Legs with black femora; first posterior cell without hyaline spot at end.

18 (19). Smaller species, with black first basal cell, with no hyaline spot at end of submarginal cell and with almost entirely hyaline second posterior cell *abyssinica*, sp. nov.
19 (18). Larger species, with hyaline spots at end of first basal and submarginal cells, and with five indistinct hyaline spots in the second posterior cell *euryomma*, sp. nov.
20 (17). Legs all orange ; first posterior cell with the typical terminal hyaline spot.
21 (22). Second posterior cell with only one hyaline indentation ; the whole wing with no more than seven hyaline spots or indentations *peringueyi*, Bezzi.
22 (21). Second posterior cell with two or three hyaline indentations ; whole wing with more than seven hyaline spots.
23 (38). Second posterior cell with two hyaline indentations.
24 (29). Wings with the base quite hyaline and with an isolated black spot at end of third longitudinal vein between the terminal hyaline spots of the submarginal and first posterior cells ; first basal cell with hyaline spot before the small cross-vein ; submarginal cell with only one hyaline spot at end.
25 (28). Hind half of the wing with well-developed hyaline spots.
26 (27). A hyaline spot in the middle of the first posterior cell *parceguttata*, Beck.
27 (26). No such spot in middle of first posterior cell ... ... *parca*, Bezzi.
28 (25). Hind half of wing with no such spots ... ... *acrosticta*, Bezzi.
29 (24). Wings with fuscous spots or bands in the hyaline base ; no isolated black spot at end of third vein.
30 (31). The hyaline spots at end of submarginal and first posterior cells narrow and united to form a single arcuate spot at end of wing ; third posterior cell with a single broad rounded hyaline spot in the middle *arcucincta*, Bezzi.
31 (30). Hyaline spots at end of the above-named cells quite separated ; submarginal cell with two hyaline spots at end.
32 (35). Wings with a whitish base, and there with some isolated fuscous spots.
33 (34). Submarginal cell with two hyaline spots at end ... *elegantula*, Bezzi.
34 (33). Submarginal cell with only one hyaline spot at end var. *diminuta*, Bezzi.
35 (32). Wings with yellowish base, and there with a fuscous oblique band, which proceeds from the fuscous part of the anal cell.
36 (37). Third posterior cell with two hyaline indentations *hessii*, Wied.
37 (36). Third posterior cell with only one hyaline indentation ; ovipositor shorter than the abdomen ... ... var. *simplex*, Bezzi.
38 (23). Second posterior cell with three hyaline indentations.
39 (40). Third posterior cell with only one hyaline indentation ; base of wing with a fuscous stripe extending from anal cell to humeral cross-vein var. *euarestina*, Bezzi.
40 (39). Third posterior cell with two hyaline indentations ; wing base quite hyaline, unspotted ... ... *biseuarestina*, Bezzi.

1. Spathulina semiatra, Loew, 1861.

One female from Durban (*F. Muir*). This specimen agrees with Loew's original description in having an entirely black abdomen, but the bristles of the head and thorax seem to be paler ; and there are two hyaline spots in the first posterior cell, not indicated in the figure, but mentioned in the description as sometimes present. My *bioculata* seems therefore to be doubtful.

2. Spathulina semiatra var. **semirufa,** Bezzi, 1924.

A recently described variety of the preceding species (Ann. S. Afr. Mus. xix, p. 535, 1924).

3. Spathulina munroi, Bezzi, 1924.

A recently described South African species (*l.c.*).

4. Spathulina munroi var. **majuscula,** Bezzi, 1924.

A recently described variety of the preceding species.

5. Spathulina anomalina, Bezzi, 1924.

A recently described South African species (Ann. S. Afr. Mus. xix, p. 536, 1924) doubtfully belonging to the present genus, like the two following ones.

6. Spathulina abyssinica, sp. nov.

A species from Abyssinia.

7. Spathulina euryomma, sp. nov.

Another species, likewise from Abyssinia. These two will be more fully described later.

8. Spathulina peringueyi, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 538, 1924).

9. Spathulina parceguttata, Becker, 1903.

I have now found that this species, originally described from Egypt, is widely spread over the whole Ethiopian Region, my *acrosticta* being probably not distinguishable from it ; in the Indo-Australian Region the species is represented by *parca*, Bezzi, perhaps only a variety.

10. Spathulina arcucincta, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 540, 1924).

11. Spathalina elegantula, Bezzi, 1924.

A recently described South African species (*op. cit.*, p. 541).

12. Spathulina elegantula var. **diminuta,** Bezzi, 1924.

A recently described variety of the preceding (*op. cit.*, p. 542).

13. Spathulina hessii var. **simplex,** Bezzi, 1924.

A recently described variety of *hessii*, Wied. (*op. cit.*, p. 543.

14. Spathulina hessii var. **euarestina,** Bezzi, 1924.

Likewise a recently described variety of *hessii*, Wied. (*l.c.*).

15. Spathulina biseuarestina, Bezzi, 1924.

A recently described South African species (*op. cit.*, p. 539).

59. Sphenella, Robineau-Desvoidy, 1830.

The present genus, previously overlooked for the Ethiopian fauna, is recognisable only by its peculiar wing-pattern, and is hardly separable from the following one.

The species are as follows :—

1 (4). Thorax, antennae and face entirely yellow.
2 (3). Pterostigma usually with one yellowish spot at end ; fuscous bands with some subhyaline dots ; apical fuscous band with a tooth-like prolongation on third vein ; fifth vein with two fuscous spots ... *marginata*, Fall.
3 (2). Stigma entirely black ; fuscous bands not spotted, the terminal one quite simple ; fifth vein with a single spot ... ... *melanostigma*, Bezzi.
4 (1). Femora broadly black at base ; antennae and face entirely black ; stigma and wing-bands quite unspotted ; terminal fuscous band without tooth *nigricornis*, Bezzi.

1. Sphenella marginata, Fallén, 1820.

This European species seems to be widely spread in South Africa, the following one being probably only a variety of it.

Three males from Durban, January and July (*F. Muir*).

2. Sphenella melanostigma, Bezzi, Denkschr. med.-naturwiss. Ges., Jena, xiii, 1908, p. 194.

Described by me from Namaqualand, but overlooked subsequently.

3. Sphenella nigricornis, Bezzi, 1924.

A recently described South African species (Ann. S. Afr. Mus. xix, p. 545, 1924).

60. Ensina, Robineau-Desvoidy, 1830.

The species here comprised are rather heterogeneous, falling into five different groups :—(1) *barnardi*, which needs probably the formation of a new genus ; (2) *sororcula* and its allies ; (3) *anceps* ; (4) *dubia* ; and (5) *ignobilis*. Only the second group is typical, some species of the others having been placed under *Oxyna* by the older writers.

The Ethiopian species are as follows :—

1 (2). Head depressed, in profile much longer than broad, with the parafacialia broader than the third antennal joint ; robust species, with four equally strong scutellar bristles and with an *Aciura*-like wing-pattern *barnardi*, Bezzi.
2 (1). Head not so elongated or not at all depressed, with the parafacialia much narrower than the third antennal joint ; wings with a different pattern.
3 (10). Scutellum with only two bristles, the apical pair quite wanting ; two i. or. ; wings with a faint scattered reticulation.
4 (5). Head depressed, with the lower border very long and with the frons twice as long as broad ; femora yellowish, more or less broadly black at base *sororcula*, Wied.
5 (4). Head not depressed, with the lower border less elongated, and with the frons not or little longer than broad ; femora black, with yellow tip, even those of the front pair.
6 (9). Wings with black stigma and with fuscous reticulation.
7 (8). Femora broadly yellow at tip ; hind tibiae yellow ; ovipositor as long as the body ; length 3 mm. ... ... *gladiatrix*, Bezzi.

8 (7). Femora almost entirely black ; hind tibiae broadly black ; length 2 mm. *liliputiana*, Bezzi.
9 (6). Wings with colourless stigma and with a very faint reticulation *evanida*, sp. nov.
10 (3). Scutellum with four bristles.
11 (22). Apical scutellar bristles much smaller than the basal ones ; palpi rather narrow and of usual shape ; frontal stripe typically not divided (except in *anceps*).
12 (17). Wings distinctly more banded than reticulate ; discoidal cell almost entirely hyaline.
13 (16). No hyaline spot at end of first posterior cell ; wing-bands well marked.
14 (15). Marginal cell with three hyaline spots ... ... *anceps*, Loew.
15 (14). The above-named cell with only two hyaline spots, the apical one being quite wanting or very faintly developed ... var. *fasciolata*, Bezzi.
16 (13). One hyaline spot at end of first posterior cell ; wing-bands less differentiated *myiopitoides*, Bezzi.
17 (12). Wings more reticulate than banded ; discoidal cell with a more extended pattern.
18 (19). Femora yellow, more or less broadly black at base ; wings with a colourless stigma and with a very pale reticulation ... ... *siphonina*, Bezzi.
19 (18). Femora black with yellowish tip, even those of the front pair ; wings with black stigma and fuscous reticulation.
20 (21). Stigma unspotted ... ... *ignobilis*, Loew.
21 (20). Stigma with a broad yellowish-hyaline spot ... var. *plebeja*, Bezzi.
22 (11). Apical scutellar bristles about as long as the basal ones ; palpi very broad and unusually developed ; frontal orange stripe divided by a white line ; back of mesonotum with broad, brown and whitish stripes ; robust species, with an extended black pattern on the wings.
23 (28). Wings with rather broad and numerous hyaline spots.
24 (27). The blackish part of the wing-pattern forms two distinct broad bands, one in the middle, the other at the apex ; only a few hyaline dots along the second longitudinal vein.
25 (26). Stigma black, with a less distinct yellowish-hyaline spot at end ; second costal cell black, with one hyaline spot at end ... *dubia*, Walk.
26 (25). Stigma black, with a distinct hyaline spot at end ; second costal cell with two regular rounded hyaline spots ... ... *magnipalpis*, Bezzi.
27 (24). No distinct blackish bands on the wing ; very numerous hyaline dots along the second vein ; stigma with regular hyaline spot ; second costal cell with two broad and numerous small hyaline spots *hieroglyphica*, Bezzi.
28 (23). Wings entirely black, with not many small hyaline dots in the middle, and with some broader spots along the border ... *cribripennis*, Bezzi.

1. **Ensina barnardi,** Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 547, 1924).

2. **Ensina liliputiana,** Bezzi, 1924.

A recently described South African species (Ann. S. Afr. Mus. xix, p. 549, 1924).

3. **Ensina evanida,** sp. nov.

A species from Abyssinia that will be fully described later.

4. Ensina anceps var. **fasciolata,** Bezzi, 1924.

A recently described variety of *anceps*, likewise from South Africa (Ann. S. Afr. Mus. xix, p. 550, 1924).

5. Ensina ignobilis var. **plebeja,** Bezzi, 1924.

A recently described variety of *ignobilis*, also South African (*op. cit.*, p. 551).

6. Ensina hieroglyphica, Bezzi, 1924.

A recently described species from South Africa (*op. cit.*, p. 552).

7. Ensina cribripennis, Bezzi, 1924.

A recently described South African species (Bull. Mus. Hist. Nat. Paris, xxx, p. 90, 1924).

8. Ensina magnipalpis, Bezzi, 1920.

One male from Natal, Isipingo, 25. v. 1908 (*F. Muir*).

61. Euribia, Meigen, 1800.

The species placed by other authors in *Oxyna* are also to be found here. The first two species belong probably to the SCHISTOPTERINAE.

1 (4). Third antennal joint with a sharp point at the upper end; body with yellow bristles and devoid of black stripes or spots on thorax or abdomen; wings with a colourless stigma and with a deep black spot in the middle of disc.
2 (3). Wing-pattern fainter and more diffuse; abdomen mainly pale yellow; ovipositor longer than the abdomen ... ... *perpallida*, Bezzi.
3 (2). Wing-pattern more pronounced and denser; abdomen entirely black; ovipositor much shorter than the abdomen ... *discipulchra*, Bezzi.
4 (1). Third antennal joint rounded at end; body usually striped or spotted, and typically with black bristles; wings devoid of deep black central spot.
5 (6). Pterostigma very small, shorter than high; scutellum with only the basal pair of bristles; bristles pale yellowish; wing-pattern radiating at apex *tuckeri*, Bezzi.
6 (5). Pterostigma of normal shape, longer than high; scutellum with four bristles; bristles mostly black; wing-pattern not radiating at apex.
7 (8). Only one i. or.; pterostigma with a yellowish-hyaline spot at base; wing-pattern as in *tessellata* ... ... *oxynoides*, sp. nov.
8 (7). Two or three i. or.
9 (10). Three i. or.; wings with a pale yellowish stigma and very faint reticulation; ovipositor as long as the body ... ... *xiphias*, sp. nov.
10 (9). Two i. or.; wings with a blackish stigma and fuscous reticulation; ovipositor shorter than the body.
11 (12). Pterostigma entirely black; wings with a broad black border, in which are included a few sharply-defined hyaline marginal spots *praetexta*, Loew.
12 (11). Stigma with a hyaline spot, or with more or less broad hyaline base.
13 (14). Stigma with one hyaline spot in the middle; mesonotum cinereous, with a broad brown stripe in the middle ... ... *peringueyi*, Bezzi.
14 (13). Stigma with yellowish-hyaline base; thorax not striped, or with three narrow stripes.

15 (16). All the frontal and thoracic bristles whitish ; hyaline terminal spot of first posterior cell broad ; discoidal and third posterior cells reticulate ... *albina*, sp. nov.
16 (15). All the frontal and thoracic bristles black.
17 (18). No hyaline spot at end of first posterior cell ; discoidal and third posterior cells reticulate ... ... *lightfooti*, Bezzi.
18 (17). A hyaline spot at end of first posterior cell ; basal part of discoidal cell and third posterior cell not reticulate, with several isolated fuscous spots.
19 (20). Wings with a distinct dark band, which includes several hyaline spots, across the middle ; apical hyaline spot much narrower than the space between the ends of 3rd and 4th longitudinal veins ... *caffra*, Loew.
20 (19). Wings devoid of a distinct dark band across the middle ; apical hyaline spot extending over the whole space between the ends of the above-named veins.
21 (24). Second posterior cell with several confluent hyaline spots of greater size.
22 (23). Thoracic dark stripes less distinct ; subapical dark band of the wings interrupted by some hyaline streaks ... ... *dissoluta*, Loew.
23 (22). Thorax with three sharply defined dark stripes ; subapical band not thus interrupted, or with a few rounded hyaline dots only *tristrigata*, Bezzi.
24 (21). Second posterior cell with three marginal and two discal hyaline spots of smaller size, all well separated ... ... *cyana*, Walk.

1. Euribia tuckeri, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 553, 1924).

2. Euribia oxynoides, sp. nov.

A species from East Africa.

3. Euribia xiphias, sp. nov.

A species from Abyssinia. This and the preceding species will be more fully described elsewhere.

4. Euribia praetexta, Loew, 1861.

One male from Durban, Umbilo, 2. viii. 1914 (*L. Bevis*).

This specimen has only two hyaline marginal spots in the marginal cell, as in Loew's figure, the middle one being wanting.

5. Euribia peringueyi, Bezzi, 1924.

A recently described South African species (Ann. S. Afr. Mus. xix, p. 555, 1924).

6. Euribia albina, sp. nov.

A species from East Africa that will be fully described later.

7. Euribia lightfooti, Bezzi, 1924.

A recently described South African species (Ann. S. Afr. Mus. xix, p. 556, 1924).

62. Campiglossa, Rondani, 1870.

Only one species, *perspicillata*, Bezzi, 1918, which is not unlike the Oriental *cribellata*, Bezzi, 1913.

63. Camaromyia, Hendel, 1914.

The two Ethiopian species may be distinguished as follows :—

1 (2). Body reddish ; wing-reticulation more fuscous, but without a darker spot at the apex ; stigma blackish with a yellowish spot ; ovipositor short *helva*, Loew.

2 (1). Body whitish ; wing-reticulation very faint, but with a darker, eye-shaped spot at the apex ; stigma colourless ; ovipositor longer than the abdomen *acrophthalma*, Bezzi.

1. Camaromyia acrophthalma, Bezzi, 1918.

A couple of specimens from Nyasaland, Limbe, 4,000 ft., 23. ix. 1916 (*R. C. Wood*). The as yet undescribed male is very like the female ; the genitalia are pale yellowish and of rather large size ; the characteristic terminal pattern of wing is even more developed.

64. Acanthiophilus, Becker, 1908.

It is very doubtful whether the present " genus " is distinct from the following one ; I place here, the following three species :—

1 (4). Wings with a faint reticulation, which is often distinguishable only on fore half or near the apex.

2 (3). Wings wholly hyaline, with the pattern reduced to a very faint reticulate spot on the fore half before the apex ; apex of wing quite hyaline *helianthi*, Rossi.

3 (2). Wing-reticulation extending across the whole wing, even if indistinct ; fore border with three blackish spots in the marginal cell ; apex of wing black *ochraceus*, Loew.

4 (1). Wings with a broad blackish patch extending across the anterior half ; posterior half reticulate ; base of wing hyaline, apex not radiating *muiri*, sp. nov.

1. Acanthiophilus helianthi, Rossi, 1790 (=*elutus*, Meigen, 1826).

Some specimens of both sexes from British Sudan, Kadroko, 12. iv. 1913 (*H. H. King*).

2. Acanthiophilus muiri, sp. nov.

Very like some species of *Trypanea*, but the wing-pattern not radiating at the apex. Distinguished from *walkeri*, Wollaston, in that the black patch of the wing does not reach the base, and is followed by a reticulation in the second and third posterior cells ; and moreover by the pterostigma being black instead of pale yellowish.

♀. Lengths of body and wing 4 mm. Occiput pale yellowish, blackish grey towards the middle. Frons about as broad as long, opaque yellowish, with whitish sides and whitish lunula ; ocellar spot a little infuscated. Antennae shorter than the face, entirely yellowish ; third joint only a little longer than the second, rounded at end ; arista bare. Face pale yellowish, without prominent mouth-border ; peristomialia pale yellowish, unspotted, almost as broad as the third antennal joint. Mouth-opening broad ; palpi whitish ; proboscis yellowish, short, thick, with short non-recurrent terminal flaps. Occipital bristles whitish, frontal bristles yellowish ; three i. or. ; genal bristle rather strong, yellowish. Thorax black, but densely clothed with opaque, light grey tomentum, devoid of any pattern ; humeri and pleural sutures obscurely reddish ; pubescence pale yellowish ; all the bristles yellowish, those of back inserted on small black dots ; dc. much before the line of the a. sa.; one mpl. Scutellum like mesonotum, but with reddish hind border ; four yellowish

bristles, the apical ones decussate and only a little smaller than the basal. Postscutellum and mesophragma grey-dusted; halteres pale yellowish. Abdomen like mesonotum, quite unspotted, with pale yellowish pubescence; ovipositor conical, shining black, about as long as the last two abdominal segments together. Legs and coxae entirely yellowish, unspotted; front femora with a row of 4–5 yellowish bristles below. Wings with a small costal bristle; third vein bare; third and fourth veins gradually diverging towards the apex; distance between the cross-veins equal to the length of the hind cross-vein; lower angle of the anal cell acute, but little produced. Veins pale yellowish at base, infuscated at end. Stigma elongate, black, unspotted. The pattern consists of a black elongate patch on the anterior half, beginning a little before the stigma and extending to the wing-tip, and there ending without radiating streaks. In the black there are the following hyaline spaces: an elongate streak at costa, beginning at the apex of the stigma (and even extending over its terminal part) and ending acutely in the middle of the marginal cell; two small spots at end of submarginal cell, one below the end of second vein, and the other before end of third vein; a small dot in the base of the first posterior cell just above the hind cross-vein; and a terminal spot, which is narrower than the space between the ends of the third and fourth veins. The second posterior cell has three deep hyaline indentations, thus forming three perpendicular dark streaks; the discoidal cell is black only to the middle, and has a hyaline spot before the end and three short indentations below; third posterior cell with a diffuse faint reticulation and with some isolated darkish spots; the base up to the basal cross-veins, the alula and the axillary lobe are whitish hyaline, the latter with a faint fuscous spot at end.

Type ♀, a single specimen from Durban (*F. Muir*), in whose honour it is named.

65. **Trypanea,** Schrank, 1795.

The forms of this "genus" are very numerous in the Ethiopian fauna, and several of them are not easy to distinguish from those of the "genera" *Euaresta* and *Euribia*. Those at present known are as follows:—

1 (14). Pterostigma very short, higher than long, or nearly as high as long.
2 (3). Proboscis long and bicubitate, pterostigma black and united with the black terminal pattern ... ... *rivularis*, Bezzi.
3 (2). Proboscis short and not distinctly bicubitate.
4 (5). Femora and halteres black; basal hyaline spot in the first posterior cell broad ... ... *kovácsi*, sp. nov.
5 (4). Femora and halteres quite yellow.
6 (9). Basal hyaline spot in the first posterior cell broad; stigma not united with the terminal pattern.
7 (8). Discoidal cell with a fuscous spot at fifth vein, or with a fuscous band extending into the third posterior cell ... ... *peregrina*, Ad.
8 (7). Discoidal cell quite hyaline, without fuscous spot or band in the middle *mundella*, Bezzi.
9 (6). The above-named hyaline spot very narrow and round; stigma united with the terminal pattern.
10 (13). Basal half of the wing prevalently hyaline.
11 (12). A yellowish patch around the small cross-vein *brachystigma*, sp. nov.
12 (11). No such yellowish patch ... ... *hemimelaena*, Bezzi.
13 (10). Wing-reticulation extending to the basal cross-veins, even into the discoidal and third posterior cells ... ... *tuckeri*, Bezzi.*
14 (1). Pterostigma elongate, distinctly longer than high (usually 2–3 times).

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* This species of *Euribia* is repeated here.

15 (42). Pterostigma usually black and always broadly united (even if it is exceptionally hyaline) with the terminal black pattern ; hyaline spot at base of first posterior cell small.
16 (21). The black terminal pattern extending towards the base to the second basal cell and even below into the discoidal cell, scutellum with two bristles only ; proboscis bicubitate.
17 (20). Wings of male with a "bulla" in the first posterior cell, just below the middle of the last portion of the third vein ; stigma hyaline.
18 (19). The dark stripe of the discoidal cell is narrow, not reaching the middle of the same cell ; first basal cell unspotted ... *bulligera*, Bezzi.
19 (18). The above-named stripe is broader, extending beyond the middle of discoidal cell ; first basal cell with hyaline spot ... *bullosa*, Bezzi.
20 (17). Wings of male without such a "bulla" ; stigma infuscated along the fore border ... ... *euarestina*, Bezzi.
21 (16). Black terminal pattern ending much before the second basal cell.
22 (33). Proboscis short ; if it is a little elongate, the terminal part is always much shorter than the basal one.
23 (26). Only two scutellar bristles.
24 (25). Abdomen with the three basal segments yellow, the fourth black ; discoidal and second posterior cells with a reticulate pattern *amplifrons*, Bezzi.*
25 (24). Abdomen entirely grey ; discoidal and second posterior cells hyaline, with a few fuscous rays ... ... *augur*, Frfld.
26 (23). Four scutellar bristles.
27 (30). Pterostigma black ; two abbreviated black rays in the terminal part of the discoidal cell.
28 (29). Bristles of thorax yellowish ; no black tooth in the first basal cell ; base of first posterior cell with two hyaline spots ... ... *goliath*, sp. nov.
29 (28). Bristles of thorax black ; a black tooth in the first basal cell along the third vein ; base of first posterior cell with only one hyaline spot *dentiens*, Bezzi.
30 (27). Pterostigma hyaline.
31 (32). Pterostigma much longer than high ; end of discoidal cell with a single black ray, the second one extending along the fourth vein *aurea*, sp. nov.
32 (31). Stigma about as long as high ; end of discoidal cell black with hyaline spots *hemimelaena*, Bezzi.
33 (22). Proboscis long and bicubitate, its terminal part being about as long as the basal one ; pterostigma always black.
34 (37). Only two scutellar bristles ; no black tooth in the basal cell ; dark ray of the discoidal cell abbreviated ; second longitudinal vein short.
35 (36). Mesonotum with a brown middle stripe, which extends to the scutellum *confluens*, Wied.
36 (35). No such stripe on mesonotum ... ... *tristicula*, Hend.
37 (34). Four scutellar bristles.
38 (41). A black tooth in the first basal cell ; thoracic bristles black or dark brownish.
39 (40). Only four posterior dark rays, all reaching the hind border of wing *auguralis*, Bezzi.
40 (39). Five posterior dark rays, the last one not reaching hind border *hexapoda*, Bezzi.
41 (38). No such black tooth ; thoracic bristles white ; four posterior dark rays *kingi*, sp. nov.
42 (15). Pterostigma always hyaline or pale yellowish, not united with the black, terminal pattern, or only very rarely by a faint narrow indefinite stripe ; proboscis always short and never bicubitate.

* This is a species of *Euaresta*, repeated here.

43 (56). Four scutellar bristles.
44 (51). The usual dark fork at apex of wing well developed.
45 (48). A yellowish patch around the small cross-vein; basal half of wing quite hyaline.
46 (47). Discoidal cell with two fuscous rays at end; submarginal cell with rounded hyaline spot just above the small cross-vein ... ... *lutescens*, Bezzi.
47 (46). Discoidal cell with only one fuscous ray at end; submarginal cell without such a complete spot ... ... *woodi*, sp. nov.
48 (45). No yellowish patch at small cross-vein; basal half of wing with faint reticulation.
49 (50). Apical scutellar bristles long; basal reticulation of the wing rather distinct; abdomen with yellowish hind border to the segments *subcompleta*, Bezzi.
50 (49). Apical bristles of the scutellum much shorter than the basal ones; basal reticulation very faint; abdomen entirely black *furcatella*, Bezzi.
51 (44). Apex of wing wholly hyaline, quite devoid of the usual dark fork or only with the lower branch, the upper one being quite wanting, or indicated only by an isolated spot at end of third vein; basal hyaline spot of the first posterior cell broad; bristles of thorax yellowish.
52 (53). Basal half of wing with faint reticulation; lower branch of the terminal fork present; abdomen reddish at base ... ... *pulchella*, Bezzi.
53 (52). Basal half of wing quite hyaline; abdomen not reddish at base.
54 (55). Lower branch of terminal fork present, and, moreover, a black spot at end of third vein ... ... *mutila*, Bezzi.
55 (54). Apex of wing quite hyaline, without rays or spots, the terminal fuscous patch being very small ... ... *bistellata*, sp. nov.
56 (43). Only two scutellar bristles.
57 (60). A narrow but distinct dark streak extending obliquely from the stigma to the small cross-vein; apical dark fork wanting.
58 (59). Lower angle of the anal cell a right angle; a complete dark band goes from the stigma across the middle of the discoidal cell to the hind border of the wing; abdomen testaceous; no abbreviated apical ray on wing *repleta*, Bezzi.
59 (58). Lower angle of the anal cell acute, no such band going from the stigma to the hind border; abdomen black or only reddish at sides; there is an abbreviated apical ray on wing ... ... *amoena*, Frfld.
60 (57). No streak at all from the stigma.
61 (62). Apical dark fork of wing complete and regular ... ... *furcifera*, sp. nov.
62 (61). Apical fork incomplete or quite wanting.
63 (64). Lower ray of the apical fork complete, the upper one being reduced to a fuscous terminal spot; thorax bluish ... ... *superdecora*, Bezzi.
64 (63). Lower ray quite wanting or abbreviated, never reaching the wing-border; no isolated spot at end of third vein.
65 (66). Terminal fuscuos spot on wing much reduced, sending no fuscous rays into the second posterior cell ... ... *bisreducta*, Bezzi.
66 (65). Terminal spot sending two fuscous rays into the second posterior cell.
67 (68). Lower branch of the apical fork abbreviated, but reaching the fourth vein; a fuscous isolated spot at end of third vein *bisdiversa*, sp. nov.
68 (67). Lower branch represented only by a short tooth, which never reaches the fourth vein, or even quite wanting.
69 (70). Species of greater size, with black bristles on head and thorax, and with the terminal half of the discoidal cell with a peculiar pattern *diversa*, Wied.
70 (69). Smaller species, with yellowish bristles, and with no peculiar pattern at end of discoidal cell.

71 (72). A fuscous costal border on the hyaline terminal part of wing *decora*, Loew.
72 (71). No such border.
73 (74). No fuscous ray in the terminal part of the discoidal cell *aira*, Walk.
74 (73). A short fuscous ray in the terminal part of the discoidal cell *stellata*, Füssl.

1. Trypanea rivularis, Bezzi, 1924.

A recently described South African species (Ann. S. Afr. Mus. xix, p. 561, 1924).

2. Trypanea kovácsi, sp. nov.

A species from Abyssinia that will be fully described later.

3. Trypanea peregrina, Adams, 1905 (=*urophora*, Bezzi, 1918).

One female from Nyasaland, Cholo, xi. 1919 (*R. C. Wood*), approaching the form *mundella*.

4. Trypanea mundella, Bezzi, 1924.

A recently described form of the preceding from South Africa (Ann. S. Afr. Mus. xix, p. 562, 1924).

5. Trypanea brachystigma, sp. nov.

A large species, very distinct on account of its very short pterostigma.

♂ ♀. Length of body 4–4·5 mm.; of wing 4·5–5 mm.; of ovipositor 1 mm.

Occiput yellowish below, black with dark grey dust above, all opaque. Frons very broad, about as long as broad, entirely reddish, opaque, flat, with a whitish ocellar triangle and whitish orbits; lunula reddish. Face short, yellowish grey, with a distinct but flat middle keel; mouth-border slightly prominent; peristomialia as broad as the third antennal joint, whitish yellow, unspotted. Antennae entirely reddish, shorter than the face; the third joint distinctly concave above, but with the upper terminal corner obtuse. Arista microscopically pubescent. Palpi pale yellowish, darkened at end, not broadened; proboscis dirty reddish, short and thick, with the terminal part not prolonged. All the ocp. white; i. vt., oc. and or. dark yellowish; two i. or. Thorax entirely grey, opaque, without distinct pattern; bristles dark yellowish, inserted on small black dots; one mpl.; dc. placed much before the line of the a. sa.; the short pubescence pale yellowish. Scutellum entirely grey, with only the basal pair of bristles, which are long and of a dark yellowish colour; postscutellum blackish; mesophragma grey. Halteres pale yellowish, with reddish knob. Abdomen, even on venter, entirely grey, opaque, with rather long whitish pubescence; terminal bristles dark yellowish; last abdominal segment of the male as long as the two preceding segments together; ovipositor shining black, as long as the last three abdominal segments. Legs entirely reddish; front femora with a row of long yellowish bristles. Wings elongate, with strong costal bristle; veins yellowish, darkened towards the end; last portions of third and fourth veins parallel; distance between the cross-veins equal to the length of the hind cross-vein; lower angle of the anal cell acute but not produced; third vein bare; stigma very short, not longer than high, entirely yellowish. Basal half of wing quite hyaline, unspotted; the terminal dark patch broad, extending across the whole terminal half of the wing from the costa to the hind border; around the small cross-vein there is a broad yellowish patch, which extends into the first basal cell. A narrow blackish streak goes from the end of the stigma to the fuscous terminal patch, which shows two hyaline triangular indentations into the marginal cell, the terminal one being much smaller than the other; a complete terminal fork and a small hyaline spot just

below the end of the second vein ; a small rounded hyaline spot near the base of the first posterior cell, above and interior to the upper end of the hind cross-vein ; the second posterior cell entirely brown, with 2–3 hyaline indentations and 1–2 rounded hyaline spots ; terminal part of the discoidal cell brown, with two hyaline spots ; end of the third posterior cell with two fuscous spots, more or less completely surrounding a broad rounded hyaline spot.

Type ♂, type ♀ and an additional female from Nyasaland, Cholo, xi. 1919 (*R. C. Wood*).

6. Trypanea bulligera, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 563, 1924).

7. Trypanea bullosa, Bezzi, 1924.

A recently described form of the preceding species (*op. cit.*, p. 564).

8. Trypanea euarestina, Bezzi, 1924.

A recently described South African species (*l.c.*).

9. Trypanea augur, Frauenfeld, 1856.

One typical male from British Sudan, Tokar, 1917 (*H. W. Bedford*).

10. Trypanea goliath, sp. nov.

A species from Arabia that will be fully described later.

11. Trypanea dentiens, Bezzi, 1924.

A recently described species from South Africa (Ann. S. Afr. Mus. xix, p. 565, 1924).

12. Trypanea aurea, sp. nov.

Distinguishable by the hyaline pterostigma, which is, however, united with the terminal fuscous patch by a broad dark streak ; also characteristic is the second dark ray of the discoidal cell extending interiorly along the fourth longitudinal vein.

♂ ♀. Length of body and wing 4 mm. ; of ovipositor 1 mm.

Occiput yellowish, opaque, with a blackish spot in the middle above the neck. Frons yellowish, opaque, a little longer than broad, with narrow greyish sides ; lunula yellowish. Face pale yellowish, with a very slightly prominent mouth-border ; peristomialia narrow ; unspotted. Antennae about as long as the face, entirely reddish ; third joint obtuse at base ; arista short, bare, thickened at base. Palpi and proboscis yellowish, the latter short and thick. All the ocp. white ; i. vt., oc. and or. yellowish ; three i. or. Thorax black, dark grey-dusted, opaque, with yellowish humeri and notopleural sutures ; the short pubescence of the back is yellowish, golden towards the sides ; bristles pale yellowish, one mpl., dc. much before the line of the a. sa. Scutellum yellowish, darkened basally, tomentose like the mesonotum, with four yellowish bristles, the apical being only a little smaller than the basal ones ; mesophragma grey. Halteres pale yellowish. Abdomen entirely grey, even on venter, with yellowish or golden pubescence ; the hind borders of the segments sometimes narrowly yellowish ; last segment of the male not much longer than the preceding one ; ovipositor shining red, with a narrow black tip, a little longer than the last two abdominal segments together. Legs entirely

yellowish ; front femora with a row of 4–5 yellowish bristles ; spur of middle tibiae dark yellowish. Wings elongate, with small costal bristle ; veins yellowish, darkened distally ; second vein straight ; third vein bare ; terminal portions of third and fourth veins gradually diverging ; cross-veins approximated, their distance being much smaller than the length of the hind cross-vein, which is straight and perpendicular ; lower angle of the anal cell acute and rather produced. Stigma elongate, more than twice as long as high ; yellowish-hyaline, but with the corresponding segment of the costa black and with the outer corner a little darkened. The terminal black patch regular, rather small, ending below at fourth vein; it is broadly united with the stigma, and has a triangular hyaline indentation on fore border just beyond the stigma, and a small rounded hyaline spot just below the end of the second longitudinal vein, and a small rounded spot near the base of the first posterior cell in contact with the upper end of the hind cross-vein. The seven fuscous rays are equally narrow ; two form the usual apical fork ; two are in the middle of the second posterior cell ; one along the hind cross-vein ; one in the end of the discoidal cell departing from the hind cross-vein ; and one of the same length, extending horizontally along the fourth vein.

Type ♂ and type ♀, and one additional female, from Nyasaland, Cholo, xi. 1919 (*R. C. Wood*).

13. Trypanea confluens, Wiedemann, 1830.

A small species, very distinct on account of the bicubitate proboscis, the presence of only two scutellar bristles, the dark middle stripe on mesonotum and the characteristic wing-pattern. I think that *tristicula*, Hendel (1914), is not distinguishable from the present species.

Some specimens of both sexes from Nyasaland, Ruo, 26. v. 1916, and Cholo (*R. C. Wood*).

14. Trypanea auguralis, Bezzi, 1908.

Very like *augur*, but at once distinguished by its four scutellar bristles. One female from Nyasaland, Limbe, 24. xii. 1916 (*R. C. Wood*).

15. Trypanea hexapoda, Bezzi, 1918.

Very like the preceding species, but distinct in having a second dark ray in the terminal portion of the discoidal cell.

One male from Nyasaland, Ruo, 26. v. 1916 (*R. C. Wood*).

16. Trypanea kingi, sp. nov.

Very like *augur* in general appearance and wing-pattern, but distinguished by the exceedingly long bicubitate proboscis and by the four scutellar bristles.

♂ ♀. Lengths of body and wing 3·5 mm. ; of the ovipositor 1 mm.

Head distinctly depressed. Occiput pale yellowish, greyish towards the middle. Frons flat and very broad, but distinctly longer than broad ; it is opaque, dirty reddish, with whitish sides, ocellar plate and middle stripe ; lunula broad, rounded, reddish yellow. Face whitish, narrow and short, with very prominent mouth-border ; peristomialia narrow, unspotted. Antennae porrect, as long as the face, entirely yellowish ; third joint concave above and with the upper corner acute ; arista bare, thickened at base. Palpi whitish, long, flattened but narrow ; proboscis reddish, very long, its basal portion longer than the mouth, and its terminal portion as long as the basal one, the whole proboscis being about as long as the body ; mouth-opening narrow and long. Eyes spheroidal ; lower border of head long. All the

ocp. are white ; oc. and or. pale yellowish ; two i. or. Mesonotum bluish cinereous, while the sides, humeri and pleurae are rather ferruginous grey ; scutellum likewise, more or less distinctly reddish at hind border ; all the bristles whitish ; dc. placed much before the line of a. sa. ; one mpl. ; four sct., the apical ones smaller, the basal ones inserted on black dots, like the prsc. and the dc. Mesophragma like the back. Halteres pale yellowish. Abdomen grey, in the male broadly reddish at sides and at base, with long whitish pubescence ; ovipositor reddish, about as long as the entire abdomen. Legs entirely reddish ; front femora with a row of long yellowish bristles below. Wings elongate, with distinct costal bristle ; third and fourth veins slightly diverging towards the apex ; cross-veins approximated, their distance being much smaller than the length of the hind cross-vein ; lower angle of anal cell acute and a little produced. Wing-pattern as in *augur*, with the following differences : the hyaline stripe in the marginal cell is smaller and less developed ; in the end of the first basal cell there is a rounded hyaline spot, incomplete below, symmetrically placed with the complete hyaline spot in the base of the first posterior cell.

Type ♂, type ♀ and an additional female from British Sudan, Kodroko, 15. v. 1910 and 2. iv. 1913, collected by *H. H. King*, in whose honour this fine insect is named.

17. Trypanea lutescens, Bezzi, 1924.

A recently described South African species (Ann. S. Afr. Mus. xix, p. 567, 1924).

18. Trypanea woodi, sp. nov.

A species with four sct. and with a typical wing-pattern, but distinguished by the fuscous yellowish patch around the small cross-vein.

♂ ♀. Lengths of body and wing 3 mm. ; of ovipositor 0·5 mm.

Occiput blackish grey in the middle, pale yellowish at sides and below. Frons about $1\frac{1}{2}$ times as long as broad, opaque yellowish, with greyish sides and ocellar spot ; lunula broad, rounded, yellowish ; face whitish, with no prominent mouth-border, peristomialia narrow, unspotted. Antennae shorter than the face, entirely reddish ; third joint rounded at end ; arista bare. Mouth-opening broad and rounded ; palpi and proboscis pale yellowish, the latter short and thick. Ocp. whitish ; i. vt., oc. and or. pale yellowish ; two i. or. Thorax entirely black, densely dark grey-dusted, opaque ; back without distinct pattern, with pale yellowish pubescence ; bristles pale yellowish ; dc. much before the line of a. sa. one mpl. Scutellum like back, with four bristles, the apical much smaller than the basal ones, which are inserted on small black dots. Halteres pale yellowish. Abdomen entirely black, dark grey-dusted, with pale yellowish pubescence ; ovipositor shining red, with a black base. Legs entirely reddish ; front femora with a row of 4–5 yellowish bristles below. Wings with distinct costal bristle ; stigma longer than high, pale yellowish-hyaline ; second, third and fourth veins straight, the two latter thus parallel in their terminal portions : distance between the cross-veins smaller than the length of the hind cross-vein ; lower angle of the anal cell acute and a little produced. Wing-pattern typical, brownish black, but around the small cross-vein there is a yellowish or blackish patch, extended interiorly into the base of the first basal cell, and superiorly to the second vein, but not reaching the stigma ; end of marginal cell, just beyond the triangular hyaline indentation, blacker than the rest ; a small rounded hyaline dot below the end of the second vein ; apical fork complete ; two dark rays in the second posterior cell, one along the hind cross-vein, the other oblique and shortened into the upper terminal angle of the discoidal cell. The hyaline spot at base of first posterior cell is large and rounded, in contact below with the ourth vein, but above not reaching the third.

Type ♂ and ♀, and numerous specimens of both sexes from Nyasaland, Cholo, *R. C. Wood*), in whose honour it is named.

19. Trypanea furcatella, Bezzi, 1924.

A recently described variety of *subcompleta*, Bezzi, 1921, from South Africa (Ann. S. Afr. Mus. xix, p. 568, 1924).

20. Trypanea pulchella, Bezzi, 1924.

A recently described South African species (*l.c.*).

21. Trypanea mutila, Bezzi, 1924.

A recently described species from South Africa (*op. cit.*, p. 569).

22. Trypanea bistellata, sp. nov.

A species from East Africa.

23. Trypanea furcifera, sp. nov.

A species from Abyssinia. This and the preceding species will be fully described later.

24. Trypanea superdecora, Bezzi, 1924.

This recently described South African species is distinguished from *decora* in having the lower ray of the apical fork complete, and the upper one reduced to an isolated spot at end of the third vein (Ann. S. Afr. Mus. xix, p. 570, 1924). One female specimen from Nyasaland (*R. C. Wood*).

25. Trypanea bisreducta, Bezzi, 1924.

A recently described South African species (*op. cit.*, p. 571).

26. Trypanea bisdiversa, sp. nov.

Closely allied to *diversa* and perhaps only a variety of it, distinguished by having an abbreviated lower ray of the apical fork, a black spot at end of the third vein, and the discoidal cell quite hyaline at the apex.

♂ ♀. Lengths of body and wing 3·5–4 mm.; of the ovipositor 1 mm.

Occiput grey-dusted, pale yellowish below and near the eyes. Frons opaque with a yellowish patch on the apical half, grey elsewhere, with narrow whitish sides and a small blackish ocellar dot; lunula broad, rounded, pale yellowish. Face whitish yellow, with a slightly prominent mouth-border; peristomialia narrow, unspotted. Antennae reddish, as long as the face; third joint rounded at end; arista bare. Proboscis short and thick, reddish; palpi pale yellowish. Ocp. white; i. vt., oc. and or. yellowish; three i. or. Thorax black, but densely clothed with yellowish-grey dust; pubescence pale yellowish; all the bristles pale yellowish, the dc. placed much before the line of the a. sa.; one mpl. Scutellum like back, with only the basal pair of bristles inserted on small black dots, like the prst. and the dc. Halteres pale yellowish. Mesophragma and abdomen like mesonotum, the latter with yellowish pubescence. Ovipositor shining black, about as long as the abdomen. Legs entirely reddish; front femora with less developed bristles below. Wings with costal bristle; second, third and fourth veins straight, the last portions of the two latter a little diverging; distance between the cross-veins about equal to or a little shorter than the length of the hind cross-vein; lower angle of the anal cell acute and a little produced. Stigma pale yellowish-hyaline, twice as long as high. Wing-pattern like that of *diversa*, with the abbreviated lower ray of the apical fork reaching the fourth

vein and with an isolated dark spot at end of the third vein; base of first posterior cell broadly hyaline and the small cross-vein not at all infuscated; discoidal cell entirely hyaline at end, the last ray being that on the hind cross-vein.

Type ♂, type ♀, and numerous specimens of both sexes from Nyasaland, Cholo and Limbe, 3,000–4,000 ft., 24. ix. 1916 (*R. C. Wood*).

Subfam. V. SCHISTOPTERINAE.

This subfamily is probably heterogeneous. Some of the genera (*Perirhithrum*, *Eutretosoma*, *Rhabdochaeta* and *Rhochmopterum*), with their white and thick ocp. and more reticulate wing-pattern, show more affinity with the TRYPANEINAE and may form a special tribe under the name RHABDOCHAETINI; the remainder (*Schistopterum* and the two new genera here erected) seem to be more nearly allied to the CERATITINAE. At any rate, the presence of the poc., or the costal nick of the wings, or both characters, are sufficient for the distinction of the subfamily as here defined.

66. **Perirhithrum,** Bezzi, 1920.

I have seen a ♀ specimen of the single known species (*P. marshalli*, Bezzi, 1920), belonging to the Transvaal Museum.

67. **Eutretosoma,** Hendel, 1914.

As previously stated, this genus is now placed in the present subfamily on account of the presence of pre-ocellar bristles, recorded in the original description of the type-species *Eutreta oculata*, Hendel, 1914. The costal nick of the wings is, however, not, or but little developed; but the wing-pattern is very typical, as appears from Hendel's figure 43 on pl. iii.

The generic characters are as follows:—

Head in front view broader than high; occiput flat or a little concave; eyes rounded. Frons flat, not prominent, broad, with parallel sides; lunula small. Antennae inserted a little above the middle of the eyes and a little shorter than the face; third joint short, but distinctly acute at end, and more or less subulate; arista microscopically pubescent. Face broad and short; peristomialia narrow; mouth-border not, or very slightly, prominent; palpi broad; proboscis short and simple. Ocp. thick and white; frontal stripe with a pair of poc.; two or three i. or. Thoracic suture interrupted in the middle; thoracic chaetotaxy complete, with developed middle scp.; dc. placed before the line of the a. sa., very near the suture. Scutellum with four bristles, the apical ones smaller. Abdomen normal, ovipositor shorter than the abdomen. Legs normal front femora with a row of bristles below; middle tibiae with one spur. Wings not broadened, with small costal bristle; all the veins bare above; stigma elongate; second vein long; last portions of third and fourth veins straight and parallel, or slightly diverging at the extreme end; fourth vein ending at wing-tip; small cross-vein placed beyond the middle of the discoidal cell, which is long and broad; lower angle of the anal cell acute and a little produced; sixth vein reaching the hind border with a spurious prolongation. Wing-pattern consisting of a close reticulation on more than the basal half, with the terminal part more lightly coloured and more diffusely reticulated, separated from the rest by a dark arched band, extending from fore to hind border of wing.

The known species are as follows:—

1 (4). Very dark or black species, with black halteres and prevalently black legs; wings more intensely black, with less striking reddish patches.

2 (3). Tibiae black, with a whitish band; tarsi in part black *polygramma*, Walk.

3 (2). Tibiae and tarsi entirely pale yellowish ... ... *woodi*, sp. nov.
4 (1). Paler or even yellowish species, with whitish halteres and prevalently yellowish legs ; wings paler, with more striking reddish patches at fore-border.
5 (6). Femora black with yellowish tips ; abdomen and ovipositor black *oculatum*, Hend.
6 (5). Femora yellowish, with a narrow black base ; abdomen like the ovipositor, mainly reddish ... ... *marshalli*, sp. nov.

1. Eutretosoma woodi, sp. nov.

Very distinct on account of its black halteres and the much darker coloration of the body, legs and wings.

♂ ♀. Length of body 2·2–2·4 mm. ; of wing 2·1–2·3 mm. ; of ovipositor 0·5 mm.

Occiput entirely black, with a narrow white border to the eyes. Frons subquadrate, only a little longer than broad, opaque, reddish, with whitish sides and with a black grey-dusted ocellar spot ; lunula whitish ; a small deep black spot on each side, just between the root of antennae and the eyes. Upper half of face black, lower half white ; peristomialia narrow, white, unspotted. Antennae shorter than the face, entirely yellowish ; third joint short, acute at end but not properly subulate ; arista whitish, thickened at base. Mouth-border not at all prominent ; palpi brown or dark yellowish, with short black bristles ; proboscis dark brown, short and thick. Ocp. white ; i. vt. yellowish ; upper or. yellowish, the two i. or. blackish ; oc. and poc. white, widely separated, the latter near the middle of the frontal stripe. Thorax entirely black, clothed on the back with opaque dark dust ; the sparse and short pubescence is whitish, like the bristles, which are thin ; pleural bristles quite white. The rather large scutellum is nearly triangular, flat above, coloured like the mesonotum ; one pair of long yellowish b. sct., and one pair of shorter and white bristles at end, the latter parallel. Calypters and halteres blackish. Abdomen entirely black, with opaque dark dust, but the hind border of the last segment is shining black, more broadly in the male than in the female ; pubescence whitish ; last segment in the male as long as the two preceding ones taken together ; male genitalia black ; ovipositor shining black, cylindro-conical, as long as the last four segments together. Coxae and femora black, the latter with narrowly reddish tips ; tibiae and tarsi entirely yellowish, but the posterior tibiae with an indistinct black ring at base ; bristles of front femora white. Wings with normal venation ; fourth vein ending at wing-tip, the portion of the wing below this vein being broader than the portion above it, the discoidal and third posterior cells being thus rather broad. The terminal fourth o. the wing is whitish hyaline, with some scattered fuscous streaks, which do not form a definite pattern ; o. these streaks, two are in the submarginal, two in the first posterior and one in the second posterior cell. The rest ol the wing is blackish ; the second costal cell has two yellowish-brown spots ; the stigma is black, with an indistinct yellowish spot ; the marginal cell has three whitish-hyaline spots at costa and some small dots along the second vein ; the submarginal cell has two deep black rectangular patches, with a small rounded hyaline dot in the centre of each patch ; alternating with these two black patches are three dark yellowish, indistinct shining patches, quite unspotted, the external one followed by three rows of small hyaline dots. First basal and first posterior cells with numerous hyaline dots, disposed in two rows ; in the discoidal cell there are two irregular rows above, and three very close rows below ; third posterior and axillary cells with very numerous dots disposed in many rows, and some larger ones along the hind border, three of which are more striking and placed at equal distances along the costal border of the third posterior cell. The unspotted arcuate band goes obliquely from the second black patch of the submarginal cell to the hind border of wing across the hind cross-vein. The remaining yellowish patches are in the middle of first posterior cell

at third vein, and two on fourth vein on both sides of upper end of the hind cross-vein, with a black patch between them, adorned by a small hyaline spot on both sides. The hind cross-vein is curved outwardly, and its distance from the small cross-vein is less than its own length.

Type ♂ and type ♀, a single couple of specimens from Nyasaland, Cholo, 16. xi. 1919 (*R. C. Wood*) ; named in honour of the collector, who has made numerous important discoveries in the Trypaneid fauna of Nyasaland.

2. Eutretosoma marshalli, sp. nov.

Easily recognisable on account of its paler yellowish body and legs and paler wings.

♂ ♀. Length of body and wing 2·5 mm. ; of ovipositor 0·3 mm.

Occiput black above, broadly yellowish below and near the eyes. Frons opaque, yellowish, with whitish sides and with a small, deep black spot in front, between root of antennae and eyes. Face whitish, with a narrow black transverse band in the middle. Peristomialia whitish, unspotted. Antennae entirely yellowish, as long as the face ; third joint acute at end and distinctly subulate ; arista yellowish, bare. Palpi pale yellowish ; proboscis short and thick. Ocp. thick and whitish ; or. yellowish, two i. or. ; oc. and poc. whitish, distant from each other, the latter in the middle of the frons. Thorax black, densely clothed with yellowish-grey, opaque dust ; humeri and notopleural stripe paler ; upper part of mesopleura and the whole sternopleura black, the pleurae appearing thus horizontally striped. Pubescence pale yellowish ; bristles yellowish or white, those of back inserted on small black dots. Scutellum yellowish with blackish base and with two blackish spots at insertion of the b. sct. ; a. sct. much smaller and more whitish. Mesophragma black, grey-dusted ; calypters and halteres whitish. Abdomen reddish, with whitish pubescence, the middle segments with two black spots each, sometimes fused together to form a single band ; last segment in the male entirely black ; ovipositor shining reddish, narrowly black at end, as long as the last two segments together. Legs entirely yellowish, but the femora with black base and with a black preapical ring ; hind tibiae with a black ring at base. Wing-pattern in general as described for the preceding species, but paler, with more striking reddish patches, and with less numerous and broader hyaline spots. The terminal sub-hyaline part has a more definite pattern, consisting of about six rounded hyaline spots disposed in two irregular rows. Stigma yellowish, with a dark spot in the middle. The reddish patches are disposed as in the preceding species, but are more evident ; there are, moreover, two deep black spots, one in the submarginal, the other in the base of the first posterior cell, the former followed and the latter preceded by a rounded whitish-hyaline spot. The yellowish-hyaline spots of the reticulate part are much broader and less numerous, only one row in the first basal and first posterior cells, two rows in the discoidal and only 4–5 in the third posterior cell, in which the larger spots are placed interiorly, instead of being at wing-border as in the preceding species. The arched, unspotted, band is incomplete and less distinct, being visible only in its inferior part along the hind cross-vein.

Type ♂, type ♀, and an additional specimen from Chirinda Forest, x. 1905, *G. A. K. Marshall*, in whose honour this fine insect is named.

68. Rhabdochaeta, de Meijere, 1904.

It is very difficult to distinguish the species of the present genus from those of the following one ; and if in future it should be found that the Ethiopian species are not congeneric with the Oriental ones, the name *Rhochmopterum* will be used for all the species here recorded.

The known species are as follows :—

1 (4). Third antennal joint black ; face black, with a white band at mouth-border.

2 (3). No a. sct. or very small ones ; femora black ; wings with a black definite pattern and with a black stigma, which bears a small hyaline spot *nigra*, sp. nov.

3 (2). A. sct. well developed ; femora orange ; wings with a brownish, less definite, not radiating pattern, and with a yellowish-hyaline unspotted stigma. *obsoleta*, sp. nov.

4 (1). Antennae entirely yellowish or reddish ; face yellowish or whitish, at most with a narrow transverse dark band in the middle.

5 (6). Wings without radiating fuscous streaks on fore border and at apex, and destitute of shining reddish " bullae " ; pterostigma quite colourless, with only a small black dot at base ; no black spots between root of antennae and eyes ; femora unspotted (here would come *Euribia perpallida* and *discipulchra*, if they belong to the present genus).

6 (5). Wings with radiating fuscous streaks and with shining " bullae " ; stigma blackish or yellowish, with a hyaline spot ; femora black-spotted.

7 (12). A black spot between root of antennae and eyes ; wing-pattern with long, diverging black rays at apex, but with no fuscous spots between them ; thorax blackish ; ovipositor as long as the abdomen.

8 (11). Marginal cell with two dark rays ; scutellum with four bristles.

9 (10). Abdomen and ovipositor prevalently reddish ; wing-pattern brownish, with a very remarkable deep black spot in the middle *neavei*, Bezzi.

10 (9). Abdomen blackish grey, ovipositor black, wing-pattern blackish, without such a striking spot ... ... *spinosa*, Lamb.

11 (8). No a. sct., marginal cell with but a single dark ray ; wings brownish, with a deep black middle spot, and with a few large rounded hyaline spots on hind border, abdomen blackish grey ... *subspinosa*, sp. nov.

12 (7). No deep black spot at root of antennae ; wing-pattern yellowish, with short radiating apical streaks and fuscous spots between them ; scutellum with four bristles ; mesonotum reddish ; ovipositor shorter than the abdomen ... ... *marshalli*, sp. nov.

1. Rhabdochaeta nigra, sp. nov.

This species may be distinguished from all the others by the prevailing black colour of the antennae, face, legs and wings ; the a. sct. are very small ; there is only one dark ray in the marginal cell. The radiating streaks at apex of wing are long, and there are no dark spots between them ; the black patch in the middle of wing is well developed, preceded by a white hyaline dot and surrounded by several shining reddish " bullae."

One female from Nyasaland, Ruo, 20. v. 1916 (*R. C. Wood*). It occurs also in Uganda.

2. Rhabdochaeta obsoleta, sp. nov.

A species from Abyssinia that will be fully described later.

3. Rhabdochaeta neavei, Bezzi, 1920.

A couple of specimens from Nyasaland, Cholo, x–xii. 1919 (*R. C. Wood*).

The as yet undescribed male is very like the female ; the poc. are well developed ; the abdomen is reddish, with the segments more or less infuscated basally ; the genitalia are reddish ; the two black rings on the four posterior femora are more complete ; the wing-pattern is the same as in female. These two specimens are distinctly larger than the type ; they measure 3–3·5 mm. in length of body and wing ; the ovipositor 2 mm.

4. Rhabdochaeta subspinosa, sp. nov.

A species from Uganda that will be fully described later.

5. Rhabdochaeta marshalli, sp. nov.

Very distinct from all the other species owing to its robust build, the prevalently reddish colour of the body, and the peculiar wing-pattern.

♂ ♀. Length of body 4·2–4·5 mm.; of wing 4·3–4·6 mm.; of ovipositor 1 mm.

Occiput entirely pale yellowish, opaque, grey-dusted, with two black spots in the middle above the neck. Frons distinctly broader than long, entirely yellowish, opaque, with whitish sides and destitute of black spots in front between the eyes and antennae; lunula whitish. Antennae distinctly separated at base, as long as the face; they are yellowish, with the third joint orange in the male, and prolonged in both sexes into a thin, acute point, being very concave on its upper side; arista yellowish at base, whitish elsewhere. Face pale yellowish, with a flat middle keel and a slightly prominent mouth-border; peristomialia whitish, narrow, unspotted. Palpi pale yellowish, with short black bristles, projecting from the mouth; proboscis short and thick. Ocp. numerous, white; all the frontal bristles likewise whitish, the two i. or. very long, as long as the i. vt.; oc. and poc. parallel and distant. Thorax entirely reddish, clothed on the back with opaque, pale grey dust; pleurae prevalently black below and clothed with grey dust, the mesopleura reddish with a black spot in the middle; bristles and pubescence pale yellowish; dc. placed very near the suture. Scutellum reddish, whitish-dusted, with four bristles; postscutellum and mesophragma black, grey-dusted, the latter with a whitish spot on each side. Calypters whitish; halteres pale yellowish. Abdomen reddish, with opaque whitish dust; 2nd, 3rd and 4th segments with a blackish transverse spot on each side, more developed in the male; pubescence whitish; last segment of the male as long as the two preceding segments together; male genitalia reddish; ovipositor shining reddish, narrowly black at end, as long as the last two abdominal segments together; venter entirely reddish, unspotted. Legs entirely pale yellowish; front femora with 5–6 yellowish bristles below; the four posterior femora with two black spots on the inner side, representing the basal and subapical rings. Wings with a distinct costal nick, strong costal bristle and elongate stigma. All the veins bare, the second long, the third and fourth diverging at end; discoidal cell broad; hind cross-vein straight, longer than its distance from the small one; lower angle of anal cell broad and acute, produced; sixth vein reaching hind border with a spurious prolongation. The wing-pattern is yellowish, with the reddish "bullae" and the black spot at base of first posterior cell well developed; symmetrically with this black spot there are three other spots, which are less dark and have all a rounded white-hyaline dot in the middle. The stigma is dark yellowish, with the end more hyaline. The radiating streaks are short, two in the marginal, two in the submarginal, three in the second posterior cell; between the rays at tip of wing there are rounded fuscous spots, which are very characteristic of the present species. Submarginal cell with some hyaline spots at base, and with four hyaline spots in the middle disposed in a curved row; first and second posterior and discoidal cells with a few rounded hyaline spots; third posterior cell with 3–4 irregular rows of rather numerous rounded hyaline spots; axillary cell with 4–5 less definite spots. Base of wing before the basal cross-veins hyaline and unspotted; second costal cell with a single, perpendicular dark streak in the middle.

Type ♂ and ♀, a single couple of specimens from Southern Rhodesia, Chirinda Forest, x. 1905, named in honour of the collector, *Dr. G. A. K. Marshall*, who has discovered three interesting South African species of this subfamily.

69. **Rhochmopterum,** Speiser, 1910.

I include in the present genus some species which have a very characteristic coloration, namely a yellowish abdomen with a shining black terminal segment; they are distinguished from the species of the preceding genus in having more numerous scutellar bristles, and by the presence of some erect, peculiar supernumerary bristles on the back of the thorax and abdomen. They are as follows:—

1 (4). The radiating streaks in the marginal cell are narrow and entirely black.
2 (3). All the orbital bristles whitish; in the brown patch in the middle of wing, extending across the end of the first basal cell and the base of the first posterior cell, there are four white-hyaline spots *neuropteripenne*, Speis.
3 (2). The first i. or. is black and thick, horn-like; in the above-named patch there are only two white spots ... ... *munroi*, sp. nov.
4 (1). The three radiating streaks in the marginal cell are triangular and whitish-hyaline, bordered with black ... ... *lutescens*, sp. nov.

1. **Rhochmopterum munroi,** sp. nov.

This South African species seems to be distinct from the type-species of the genus by the characters given in the table; it has, moreover, the small cross-vein well developed as usual, not obliterated, as stated by Dr. Speiser for his species.

One female from Nyasaland, Cholo, xii. 1919 (*R. C. Wood*).

2. **Rhochmopterum lutescens,** sp. nov.

This species, from Uganda, is very distinct from all the others on account of the peculiar rays on the fore border of the wing.

70. **Schistopterum,** Becker, 1903.

The single known, Egyptian species, *S. moebiusi*, Beck., is present even in the true Ethiopian Region, for I have seen in the Budapest Museum one specimen from East Africa.

71. **Brachiopterna,** gen. nov.

This new genus, of which only one species from East Africa (*B. katonae*, Bezzi) is known, is at once distinguishable by the very short discoidal cell, as well by the peculiar wing-pattern, which, however, in its main lines recalls that of the preceding species.

72. **Bactropota,** gen. nov.

This new genus is erected for one of the most striking acalyptrate flies of the whole Ethiopian fauna; the shining black body, the very long antennae and palpi; the reduced chaetotaxy of the head and the very peculiar wing-pattern give it a strange and unique appearance.

Head rather depressed, in front view much broader than high, in lateral view subquadrate, with equally prominent frons and mouth-border; it is broader than the anterior part of thorax. Occiput flat, a little concave above and not swollen below. Frons longer than broad, with parallel sides, deeply concave along the middle; there is a narrow, elongate, shining black ocellar triangle extending to a little before the root of antennae. Lunula small, visible only from in front. Face narrow, only one-half as broad as the frons, concave in the middle, with very prominent mouth-border; parafacialia and peristomialia linear; eyes broadly

ovate, with their longest diameter placed rather obliquely. Antennae inserted at upper border of the eyes, on a very prominent, rounded tubercle; they are rather distant at base; the two basal joints are very short; third joint exceedingly long, linear, gradually attenuated towards the end but not properly pointed, pendulous, about twice as long as the face; arista basal, as long as the third joint, thickened basally, with microscopical, white pubescence. Palpi very long, flattened, parallel-sided, obtuse at end, projecting much beyond the mouth, quite bare. Proboscis short and thick, with the terminal flaps not prolonged. The whole head is shining and quite bare, except for the bristles, which are as follows: ocp. indicated only by very short, black, acute setulae; one distinct pvt.; outer vt. very thick and white, inner vt. very long and black; no oc. or poc.; or. black, well developed, one pair of superior and two pairs of inferior ones, all placed very near the eyes, the former being in a line with the latter. Thorax longer than broad, not very convex above, with the suture broadly interrupted in the middle; the short pubescence is quite wanting; the bristles are as follows: middle scp. long and thin, approximated, white; one hm., two npl., one dc. very near the suture, one prsc. very widely separated; one a. sa. and one p. sa.; one strong white pt. and one short black st.; the mpl. are not visible in the types. Scutellum broad, flattened above, rounded behind, with a pair of long black basal and a pair of short white, not decussate, apical bristles. Abdomen ovate, as broad as and as long as the thorax, with short pubescence; in the male there are four segments, the last of which is as long as the two preceding ones together; in the female there are 5 segments, the ovipositor being broad and flat, short, about as long as the last two segments together. Legs rather short but otherwise normal; front femora with only two bristles below near the end; middle tibiae with one spur. Wings proportionately long and narrow, obtuse at the apex, with rather parallel sides; the incision of the costa is well developed but not very broad, the nick being, therefore, not very distinct, bearing a strong bristle; axillary lobe very prominent, rounded; alula well developed, rounded. Stigma elongate, but the first vein ending much before the small cross-vein. Second vein straight, suddenly curved forward before the apex, ending mid-way between the apices of first and third veins. Third vein bare, straight, ending a little before the wing-tip. Fourth vein very close to the third and parallel with it, but suddenly curved downwards near the end, the first posterior cell being thus dilated outwardly. Small cross-vein well developed, placed beyond the middle of the discoidal cell; hind cross-vein placed just opposite to the end of the second vein, curved, inwardly oblique, the lower external angle of the discoidal cell being broadly obtuse, its distance from the small cross-vein being about equal to its own length. Fifth vein ending just a little beyond the lower end of the hind cross-vein, much before reaching the hind border of wing. Discoidal cell long, rather broad, ending beyond the middle of wing. Anal cell large, but obtuse below; sixth vein abbreviated, not reaching the hind border of wing; second basal cell as broad as the anal cell, but distinctly longer, its terminal cross-vein being very oblique inwardly. Wing-pattern black, radiating at apex, with broad, shining reddish, long "bullae," but without hyaline spots.

Type: The following new species.

1. Bactropota woodi, sp. nov.

A beautiful and strange fly, looking very different from an ordinary Trypaneid.

♂ ♀. Length of body 2·5 mm.; of wing 2·8 mm.; of antenna 0·7 mm.

The head is shining black, very glistening; the frontal band is of a deep velvety black colour, reddish brown on the anterior half, but divided by the narrow, long, shining black ocellar triangle. Antennae entirely black; arista white, with yellowish base. Palpi entirely black; proboscis dirty yellowish. All the cephalic bristles are black, except the thickened outer vt., which are white. Thorax entirely shining

black, but with two rather broad velvety black stripes, which are united in front above the neck, and passing across the dc. gradually diverge behind and end at the sides of the scutellum, without being continued on to it. Pleurae unspotted. There is no pubescence; in front of the scutellum there are apparently some caducous white setulae; the bristles are dark yellowish or blackish, but the scp. and the strong pt. are white. Scutellum entirely shining black like the mesonotum and likewise bare; the long basal bristles are black, while the short apical ones are snow-white. Calypters and halteres black. Abdomen shining black, with short dark pubescence and a few blackish bristles at the apex; male genitalia and ovipositor shining black, the latter very short. Legs with black coxae and femora, and pale yellowish tibiae and tarsi; but the extreme base of the four posterior tibiae and the last joint of all the tarsi are blackened; bristles of front coxae blackish. Costa and veins black on the black parts of wing, but yellowish on the hyaline parts. Wings hyaline, with a peculiar black pattern, consisting of a broad band which at base extends across the whole wing, from costal cells and stigma to the middle of the axillary lobe; just beyond the stigma this band becomes narrowed, lying between the ends of the 2nd and 5th veins, and becoming gradually narrower ends between the 3rd and 4th veins, reaching the wing-border as a downwardly curved point, along the curved terminal part of the fourth vein. There are only four radiating streaks; the first short, narrow and recurrent, at end of second vein; the second broader, almost triangular, in the middle of the submarginal cell; the third along the end of fourth vein, as stated above; the fourth and last, a little before the end of the discoidal cell, short and narrow. The stigma is quite black and hardly visible, and just beyond it there is a short, black, tooth-like projection. The reddish, elongate "bullae" are in the basal half of submarginal cell, nearly the whole first posterior cell, the base of second posterior cell, and in the entire discoidal cell except only the terminal lower stripe; they are visible only by transmitted light, appearing merely shiny by reflected light. The whole posterior border of wing is whitish-hyaline, without any vein and interrupted only by the black streak beyond the end of the discoidal cell, simulating the end of the fifth vein.

Type ♂ and ♀, a single couple of specimens from Nyasaland, Ruo, 200 ft., 15. ix. 1916, "on leaves of sweet potato"; another of the numerous discoveries of *R. C. Wood*, in whose honour this extraordinary insect is named.

CORRIGENDA.

Owing to a misunderstanding, certain species dealt with in the first half of this paper were mentioned as new, although they had already been described in another publication. The correct references to the original descriptions are given below, together with a few other emendations.

p. 97. *Carpophthoromyia angusticeps*, Bezzi, Bull. Mus. d'Hist. Nat. Paris, xxix, p. 525, 1923.
p. 103. *Pardalaspis asparagi*, Bezzi. This species was erroneously erected on a very small female specimen of *Ceratitis capitata*, W.
p. 103. *Pardalaspis roubaudi*, Bezzi, Bull. Mus. d'Hist. Nat. Paris, xxix, p. 527, 1923.
p. 104. *Pardalaspis bipustulata*, Bezzi, Bull. Mus. d'Hist. Nat. Paris, xxix, p. 528, 1923.
p. 104. *Pardalaspis cyanescens*, Bezzi, Bull. Mus. d'Hist. Nat. Paris, xxix, p. 529, 1923.
p. 104. For *Haplolopha* read *Hoplolopha*.
p. 111. *Hoplandromyia*, Bezzi, Bull. Mus. d'Hist. Nat. Paris, xxix, p. 577, 1923.
p. 115. *Hermannloewia mutila*, Bezzi, Bull. Mus. d'Hist. Nat. Paris, xxix, p. 580, 1923.
p. 115. *Zacerata*, Coquillett, Proc. Ent. Soc. Washington, xxvi, p. 64, 1924.

THE IMMUNITY OF APPLE STOCKS FROM ATTACKS OF WOOLLY APHIS (ERIOSOMA LANIGERUM, HAUSMANN).

PART II. THE CAUSES OF THE RELATIVE RESISTANCE OF THE STOCKS.

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Part I of this paper* dealt with the relative resistance of the stocks experimented with, but no attempt was made to explain the causes. An attempt to do this is made in this portion of the paper.

I again desire to acknowledge my indebtedness to Professor H. M. Lefroy and Mr. R. G. Hatton. Many thanks are also due to Dr. Davidson, who has very kindly discussed the work with me and given me much help with questions of special technique. I regret that I have not been able to refer to his most recent work more fully, but this paper was almost complete before his last paper appeared. He, however, very kindly explained the main facts to me. I also owe much to Mr. Hales, of the Chelsea Physic Garden, for the great care he has taken of the stocks, which has done much to forward the work.

The Formation of Galls.

No detailed account of gall formation will be given, but a short statement of the main processes which take place must be included in this paper in order that the observations recorded may be fully understood.

The stages are roughly as follows :—

(1) The cambium is affected, almost certainly by the salivary secretion of the Aphid, in such a way that each cell divides many times in more rapid succession than is usual. Though the stylets do not actually reach the cambium, the few phloem cells intervening prove no barrier ; the saliva is able to traverse them. The cells formed by this rapid division and redivision of the cambium are considerably larger than they should be. These abnormal productions of the cambial divisions constitute the gall tissue.

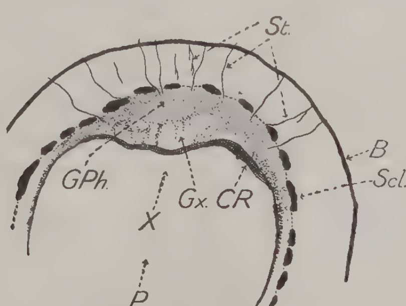

Fig. 1. Transverse section through a gall of about four weeks' growth, showing the stylets and stylet tracks : *B*, bark ; *CR*, indistinct cambial region of the gall ; *GPh*, gall tissue replacing phloem ; *Gx*, gall tissue replacing xylem ; *X*, xylem ; *P*, pith ; *Scl*, sclerenchyma ; *St*, stylets.

(2) Later, the medullary rays are affected in such a way that they also give rise to gall tissue. The effect, as seen in transverse section (fig. 1), is as though a portion of the xylem had been cut out. The gall tissue which has apparently replaced the

* Jl. of Pomology & Hort. Sci. iii, no. 2.

missing xylem is rendered exceptionally distinct if the section be stained with safranin the gall tissue does not stain. So far as can be seen at present, the xylem vessels are scattered throughout the gall tissue.

(3) The cells of the masses of sclerenchyma lose their cohesion, and also, it appears, become scattered throughout the gall tissue.

(4) The pressure produced by the exceptional activity of the cambium causes the cells of the gall to collapse, the result being that the inside mass becomes pulpy. It is possible that this condition of the tissue, together with the pressure present, assists the Aphid in the operation of sucking up the sap.

The Path of the Stylets of the Aphid through the Tissues of the Stock.

Before dealing with the path of the stylets, it is necessary to mention the fact that the rostrum of the insect can be retracted into the head for about two-thirds of its length ; this invagination accounts for the great length of stylets available for insertion in the tissues. Davidson has shown that this retraction occurs and the present writer has himself observed it (fig. 2).

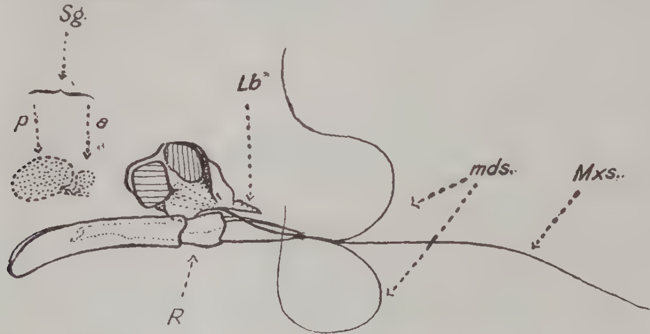

Fig. 2. Mouth-parts of *Eriosoma lanigerum*, viewed laterally, showing the retraction during suction : *Sg*, salivary gland (*a*, anterior ; *p*, posterior) ; *Lb*, labrum ; *R*, rostrum (labium) ; *mds*, mandibular stylets ; *Mxs*, maxillary stylet.

It has already been stated, in Part I of this paper, that the young wood at the tip of a stock is more easily infected than the younger parts of the older wood. Accordingly, two samples were sectioned in the hope of finding some definite morphological character which would account for it. It was, however, realized that there was little chance of discovering such characters at this stage of the work ; a knowledge of the path of the stylets, and of the action of the salivary secretion of the Aphid on the individual cells of the stock, was required.

It was found that a period of three days was required to enable the Aphids to insert their stylets to the utmost limit, without the undesirable formation of galls. The stem and Aphids were plunged into the fixative, thus fixing them *in situ*. The material was fixed first in Farmer's Fluid, which gave fairly good results ; hot Fleming, Carnoy, and Bouin's corrosive fixative were also tried. A mixture of equal parts of a saturated solution of corrosive sublimate in distilled water and of 70 per cent. alcohol was found most satisfactory, if used hot. The material was imbedded in paraffin wax, with a melting point of 58° C. Some of the best sections were obtained with a hand microtome, but many good series were cut with the Jung sliding microtome.

Sections were stained for from half an hour to three hours, according to the results required, with safranin (Grubler's safranin O). Equal parts of saturated solutions of safranin in absolute alcohol and in distilled water were used, the sections being counter-stained with Erhlich's haematoxylin for about one minute.

Numerous transverse sections, showing the stylets, were cut; from these it was found that the stylets were more often contained in from two to five consecutive sections 8μ thick. The stylets therefore pursue a winding path; in some instances their point of insertion and their ends were both contained in one of a series of four sections. Those seen in the first few series of sections passed consistently between masses of sclerenchyma and so into the phloem (fig. 3). Later, a section was obtained in which the stylets had just touched the end of a mass of sclerenchyma; they had bent round and were thus enabled to pass on into the phloem (fig. 4).

Many sections were obtained demonstrating that the stylets had paths similar to that shown in fig. 5; here it is seen that the stylets have encountered the mass of sclerenchyma at a point some distance removed from its end. The stylets were again able to bend round the sclerenchyma and penetrate the phloem; this clearly established the area that they penetrate to. The stylets were always seen to penetrate the phloem to within three or four cells of the cambium. A number of different varieties of stocks were sectioned, along with the Aphids, and similar results were obtained in each case.

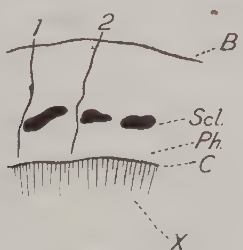

Fig. 3.

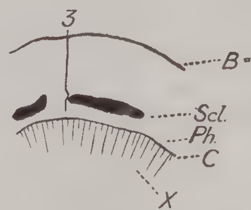

Fig. 4.

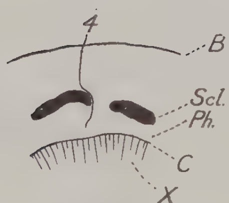

Fig. 5.

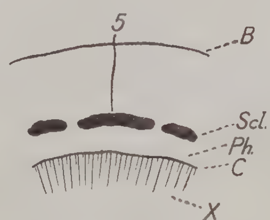

Fig. 6.

Figs. 3–6. Showing the paths traversed by the stylets of *Eriosoma lanigerum* in five different cases: *B*, bark; *Scl*, sclerenchyma; *Ph*, phloem; *C*, cambium; *X*, xylem; 1–5, stylets.

The question now arose as to what would happen in a case where the stylets met a mass of sclerenchyma which was wider than would allow them to bend round. In such an instance they would not reach the phloem. When the stylets of the Aphid are withdrawn from the tissues of the stem, a clear tube remains. From this tube the path of the stylets can be determined for some time after their removal. Several sections revealed the fact that the stylets could be pulled back slightly and then pushed forward in a new direction. This was seen to take place in an example where the stylets had arrived opposite the centre of a mass of sclerenchyma (fig. 6). In a great number of instances the stylets had been withdrawn, owing to the fact that the phloem could not be reached.

The Possible Importance of the Sclerenchyma.

From the account of the path of the stylets which has been given it would seem that the sclerenchyma may be a large factor in the question of resistance to attack. It has already been mentioned that infections were more easily made on the young wood than on the older wood. Accordingly transverse sections were cut of the young wood at the tip of a stock (Type I was selected) and also at the second internode from the tip. The sections were stained with safranin and Erhlich's haematoxylin.

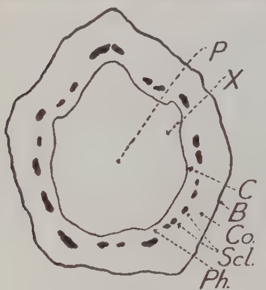

Fig. 7. Type I near tip.

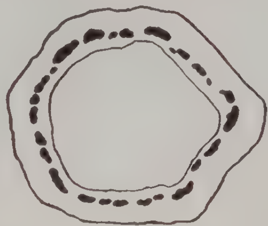
Fig. 8. Type I near centre of second internode from tip.


Fig. 9. Crab Type F near tip.


Fig. 10. Crab Type F.

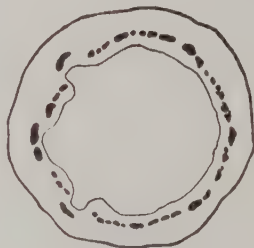
Fig. 11. Type II.

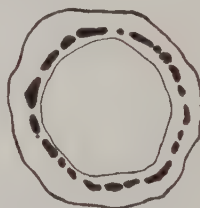
Fig. 12. Type XII.


Fig. 13. Transparent de Croncel.


Fig. 14. Crab Type H.


Fig. 15. Gascoyne Scarlet.

Figs. 7–15. Transverse sections through the young wood of various kinds of apple stocks: *P*, pith; *X*, xylem; *C*, cambium; *Ph*, phloem; *Scl*, sclerenchyma; *Co*, cortex; *B*, bark; figs. 8 and 10–15 are taken from similar positions for purposes of comparison.

It was at once seen that the amount of sclerenchyma varied considerably in the two sections (figs. 7 and 8). It will be seen that the masses of sclerenchyma were further apart and smaller in the younger wood. Layered Crab F is not so easily infected at the tip as at the second internode from the tip. Figures 9 and 10 seem to throw some light on this, the amount of sclerenchyma being greatest in the younger wood. A number of other varieties were examined in this way, and in all of them

differences were found similar to those already discovered in Type I; Crab Type F is therefore the exception to the rule.

It was realised that it was necessary to obtain some figure which would represent the amount of sclerenchyma and explain its arrangement in masses. The sections were therefore traced carefully by means of a camera-lucida. The masses of sclerenchyma were measured with the aid of a pair of dividers and their lengths laid down in one straight line. The openings between masses of sclerenchyma were also measured in the same way. The two lengths obtained were then compared so as to express the amount of sclerenchyma as a percentage of the circumference of the stem in that region.

This method, when applied to the sections of Type I and Crab Type F, gave very definite results. The percentage of sclerenchyma in the young wood of Type I was only 45 per cent. as against 72 per cent. in the older wood of the second internode. The young wood of Crab Type F possessed 80 per cent. of sclerenchyma, only 64 per cent. being present in the older wood. Further, it was observed that the masses of sclerenchyma were broken up to a greater extent in the older wood of Type F of the crab stocks; these masses were also relatively smaller than in the younger wood. It was thought necessary to find a second figure to qualify the first. The openings between the masses of sclerenchyma were counted, this figure being found of great value; it will be referred to as the "number of penetration areas." For example, the stems of two stocks might each have 75 per cent. of sclerenchyma; if one stem were to have thirty openings between the masses of sclerenchyma round the circumference, while the other only had twenty, it would be reasonable to expect that the first stock would be more susceptible to attack.

A careful comparison of all the types of stock was then made. The centre of the second internode from the tip was sectioned in every instance, care being taken that the samples of wood should be as near in vigour and general characteristics as possible. They were selected so as to be similar to the wood on which infections had been made and were taken from the same stock, and, when feasible, the wood just adjacent to an infection was sectioned. If doubt arose in connexion with any figures, they were verified from other stocks of the same type. The two values before mentioned were calculated for each stock, and the figures were found to be as follows:—

Stock.	Percentage of Sclerenchyma.	Number of Penetration Areas.
Type I (fig. 8)	72%	26
Type II (fig. 11)	64%	42
Type III	66%	33
Type IV	70%	25
Type V	68%	49
Type VI	66%	31
Type VII	72%	31
Type VIII	71%	28
Type IX	75%	35
Type X	73%	34
Type XI	73%	37
Type XII (fig. 12)	74%	22
Type XIII	74%	23
Type XIV	70%	29
Type XV	73%	37
Type XVI	77%	27
Crab F (fig. 10)	64%	50
Crab H (fig. 14)	76%	21
Transparent de Croncel (fig. 13)	77%	19
Northern Spy	73%	40
Winter Majetin	80%	24

The above figures make it quite clear that the percentage of sclerenchyma is not the reason for complete immunity, since Northern Spy and Types X and XI have the same percentage of sclerenchyma; of these stocks only Spy is immune. Types X and XI, however, are resistant. To say that a stock is immune means that it is not susceptible to attack at all; a resistant stock is one which is attacked to a slight extent only. In this paper the term "immune" will be intended to convey the meaning "completely immune" as distinct from mere "resistance."

The same series of stocks have already been placed in groups according to degrees of resistance, and this table is here reproduced, to facilitate comparison :—

Table A.

Group 1. (Very susceptible).	
Type I.	(Broad-leaved English Paradise).
Type II.	(Doucin).
Type III.	(Hollyleaf).
Type V.	(Doucin Ameliore).
Type VI.	(Nonsuch).
Layered Crab F.	(Of French origin, but growing at East Malling to compare with Paradise; large-leaved, vigorous growing type).
Group 2. (Susceptible).	
Type IV.	(Dutch Paradise).
Type VII.	(Possibly old English Paradise).
Type XI.	(Unnamed type of vigorous Paradise).
Type XII.	,, ,, ,, ,,
Type XIV.	,, ,, ,, ,,
Group 3. (Resistant).	
Type VIII.	(French Paradise).
Type IX.	(Jaune de Metz).
Type X.	(Unnamed type of very free-growing Paradise).
Type XIII.	,, ,, ,, ,, ,,
Type XV.	,, ,, ,, ,, ,,
Group 4. (Immune).	
Layered Crab H.	(Of French origin, but growing at East Malling to compare with Paradise types; small leaves, very spiny, dwarfish growth).

A variety of apple known as Zuccamaglio Reinette has been reported from Austria as being immune from Woolly Aphis; this is most noticeable in grafted trees, the bark below the graft being infested, while the grafted portion is quite free (Salmen, Ref. 4). Material of this apple has been obtained and it will be tested for its immunity in this country and for its suitability as a stock.

The Importance of the Sclerenchyma in connexion with Resistance.

Comparing the two tables, a distinct agreement is at once evident. It is true that there are exceptions, but they are probably indications of other characters upon which the degree of resistance depends. It is now possible to account for the distinct differences in susceptibility to attack. It is quite clear that the chances of an Aphid penetrating to a point near to the cambium bear a definite relation to the percentage of the prohibiting factor, or sclerenchyma. There must also exist a definite relation between the chances of penetration and the number of penetration areas. The above relation may be expressed more clearly in another form: as the percentage of sclerenchyma in the circumference of the stem increases, with a corresponding decrease in the percentage space between the masses of sclerenchyma, so will the susceptibility to attack decrease. The more broken up the masses of sclerenchyma become, *i.e.* the greater the number of penetration areas round the circumference, the greater the susceptibility to attack. The most favourable condition, from the point of view of resistance to attack, is that the percentage of sclerenchyma shall be as high as possible, that the masses of sclerenchyma shall be as large as possible, *i.e.* the number of

penetration areas shall be reduced to a minimum. It will be seen later that there are certain other considerations with regard to the amount and arrangement of the sclerenchyma, but they do not materially affect the broad principles. An approach towards the ideal condition is seen in the case of the varieties of apple known as Transparent de Croncel (fig. 13) and Gascoyne Scarlet (fig. 15).

The writer has, in his own garden, several apple trees; included in these were two Cox's Orange Pippins which were heavily attacked by Woolly Aphis; there is also another tree which is never attacked, despite the fact that one of the Cox's Orange was growing so close to it that their branches interlaced. The Cox's Orange was finally killed by the Aphid. Sample apples, wood and leaves of this immune tree were sent to Mr. R. G. Hatton at East Malling Research Station. He was unable at first to identify it conclusively, owing to the smallness of the fruit then available. Though once thought to be Pott's Seedling it has now proved to be Transparent de Croncel; and all attempts to infect it have failed. Transparent de Croncels were selected independently by means of an examination of sections of the wood. The supposed Pott's Seedling was propagated along with Croncel material which was known to be true to name. Maidens of the seemingly different varieties are now growing at East Malling, and it has been impossible to distinguish them in any way, even by an examination of the structure of the stem.

Wound Tissues.

Another Cox's Orange Pippin had a particularly severe infestation on the large amount of wound tissue present. Wound tissue was also present on the Croncel, but it was found impossible to infect it. Sections from the wound tissue from the two varieties showed the reasons for this immunity (fig. 16, II). It will be seen that there are eight rows of sclerenchyma present in the wound tissue taken from the Croncel as against only two irregular rows in the Cox's Orange Pippin (fig. 16, I), and it is obvious that the number of rows of sclerenchyma in the case of the Croncel

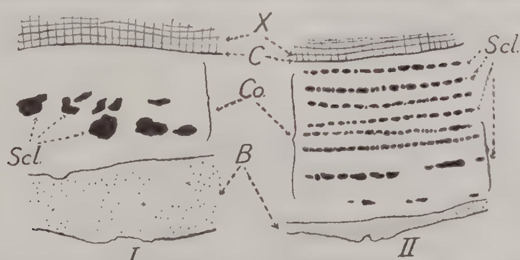

Fig. 16. Transverse sections of the wound tissue of (I) Cox's Orange Pippin, (II) Transparent de Croncel.

must offer a very much greater check to the stylets of the Aphid in its search for the cambial region. The rectangular masses in the Croncel are often seen to be opposite spaces in the next row. It is interesting to note that the bark of the Cox is relatively thicker than that of the Croncel, as compared with the width of the cortex, though perhaps not so compact; this would seem to indicate that the thickness of the bark is not an important factor in resistance.

Comparison of the Grouping made by Infection and Microscopical Examination.

The stocks were re-arranged according to percentage of sclerenchyma, as follows:—

Group 1. 61 per cent. to 65 per cent.
Group 2. 66 per cent. to 70 per cent.
Group 3. 71 per cent. to 75 per cent.
Group 4. 76 per cent. to 80 per cent.

TABLE B.

Stock.	Percentage of Sclerenchyma.	Number of Penetration Areas.
Group 1.		
Crab F.	64%	50
Type II.	64%	42
Group 2.		
Type VI.	66%	31
Type III	66%	33
Type X	68%	49
Group 3.		
Type IV	70%	25
Type XIV	70%	29
Type VIII	71%	28
Type VII	72%	31
Type I	72%	26
Northern Spy	73%	40
Type XI	73%	37
Type XV	73%	37
Type X	73%	34
Type XII	74%	22
Type XIII	74%	23
Type IX	75%	35
Group 4.		
Crab H.	76%	21
Type XVI	77%	27
Transparent de Croncel	77%	19
Winter Majetin	80%	24

The above table (Table B) may now be compared with the grouping of the stocks based on the actual infections (Table A), which has been reproduced from Part I of this paper.

Table B, Group 1.

Crab F and Type II are found to stand by themselves when arranged according to the percentage of sclerenchyma ; this is what we should expect, since they are the two most susceptible varieties of those tested.

Table B, Group 2.

These are all included in Group I (Table A). This again is as it should be, Types III, V and VI being slightly less susceptible than Type II and Crab F, which are placed in Group 3 of Table A.

Table B, Group 3.

The majority of the stocks are included in this group. It will be seen that Types IV, VII and XIV, which have not more than 72 per cent. of sclerenchyma and form part of the lower half of Group 3 (Table B), are all placed in Group 2 (Table A) ; but the principle still holds, as the arrangement in Table B was made by allowing the same range in the percentage of sclerenchyma for each group.

Type I is an exception, and appears in Group 1 (Table A), being about equally susceptible with Types III, V, and VI.

Types IX, X, XIII and XV agree in both tables. Types XI and XII come a little lower in Table A than would be expected from the percentage of sclerenchyma. Types XI and XII are close together and are both rather more susceptible than types

IV, VII and XIV; Types XI and XII, though not very definite exceptions, are perhaps best considered as such. Type VIII, though falling into Group 3 in both tables, has parted company from Types IV, VII, and XIV. In Table A this stock is classed with Type IX, but it is appreciably less resistant. Type VIII, with 71 per cent. sclerenchyma, might be expected to be more resistant than Types IV and XIV and more susceptible than Type IX; this has proved to be the case by the infection experiments. But Type VIII has a smaller percentage of sclerenchyma than Types XI and XII, which are slight exceptions. Type VIII, therefore, will not be treated as an exception.

Table B, Group 4.

These are all exceptions in so far as the percentage of sclerenchyma does not explain immunity, but only resistance. Apart from this there are no exceptions. All the stocks with a high percentage of sclerenchyma are found to head the list in both tables. Type XVI has not yet been placed in any group of Table A. It will probably come in Group 3, near the top. The number of penetration areas in Type XVI is 27, as against 21 in Crab H; the percentage of sclerenchyma being 77 per cent. as against the 76 per cent. of Crab H. Type XVI and Crab H are theoretically, therefore, of about equally high resistance. Crab H, by virtue of some unknown characteristics, is immune.

Both De Croncels and Winter Majetin have a high percentage of sclerenchyma and a low number of penetration areas, which warrant their association theoretically with Crab H. They have proved to be immune by experiment. Northern Spy is a most decided exception, appearing as it does in Group 3, Table B, though its immunity has been proved.

Conclusions drawn from the Comparison of Tables A and B.

The comparison of the two tables shows that, while the rule based on the percentage and distribution of the sclerenchyma holds fairly well for the series, there is a disparity about the middle. This disparity indicates the presence of other characters which play a part in resistance and immunity. The view that other factors exist is strengthened by a consideration of Northern Spy, Crab H, Transparent de Croncel and Winter Majetin. If the nature of the sclerenchyma in these varieties were the only explanation of resistance and immunity, the stylets of the Aphid must be able to penetrate such a ring of protective tissue; the chances of success for the Aphid might be quite small in some cases, but the structural obstacles in the plant would not be insuperable. If a complete ring of sclerenchyma were present, gall formation would still take place, as will be explained later, but such a stock would be highly resistant.

The Length of the Stylets of the Aphid and its Connexion with Gall Formation.

There are several minor variations in the structure of the stem which it is interesting to examine; but before dealing with these, the length of the stylets of the Aphid in relation to the distance between the bark and the point to which the stylets penetrate should be borne in mind.

Davidson (1) considers that the length of the stylets of different species of Aphids may be important " as affecting the relative accessibility of the tissues rich in sap." The present writer has for some time thought that a difference in the length of the stylets of *Aphis pomi* and *Eriosoma lanigerum* might account for the fact that, whereas they may both be feeding together on the same stock, only *E. lanigerum* forms galls.

To test this theory the stylets were dissected out of six fully-grown apterous viviparous females of each species. They were then mounted in glycerine, traced with the aid of a camera lucida and carefully measured. The mean of the measurements was then obtained for each species and the results were as follows :—*E. lanigerum*, 9·0 ; *A. pomi*, 7·16 units.

From the examination of cleared specimens of the Aphids, it was established that of the total length of the stylets about one-fourth lay between their internal ends and the point at which they left the shelter of the labium. It was also seen that the labium could be retracted into the head up to two-thirds of its length (fig. 2), so that of the length of stylets beyond the tip of the labium only an additional one-third is covered by the labium. Applying these factors to the mean lengths previously obtained, it follows that the length of stylets available for insertion into the tissues is 4·5 units in *E. lanigerum*, as against 3·58 units in *A. pomi*.

The distance between the bark and the cambium was measured in several varieties ; and the figures for Type I and Type X were 5·0 and 5·2 units respectively. These figures show that a stylet 4·5 units long would reach to the required point near the cambium (see fig. 3).

The young stages of the Aphid could not, therefore, reach the cambium with their stylets. The writer considers the formation of galls by the young stages to be doubtful ; it is possible that the cortical cells (or the tissue of a gall previously formed by other individuals) supply all the nourishment required, until the stylets are of sufficient length to reach the cambium.

The stylets of *A. pomi* pursue a more winding path, and so would not reach quite so far as might be expected from their length. This is because the stylets of this species generally pierce the plant tissues intercellularly, while the stylets of *E. lanigerum* pass through the tissue intracellularly and reach the cambium by a more direct path. *A. pomi* was sectioned *in situ*, and the stylets were seen to end in the cortex, well removed from phloem. Mr. A. M. Massee informs me that he has obtained similar results. The stylets of *A. pomi* could not penetrate so far, as only 3·58 units were available.

A colony of thirty-six individuals of *E. lanigerum* on a young apple stem, and containing individuals in all stages, was fixed *in situ*. The Aphids were carefully removed by means of a fine brush. Aphids on young wood were used in order that the stylets might leave the wood easily and not be damaged.

The length of the stylets protruding beyond the tip of the labium was measured, and a number of these Aphids were partly dissected, in order to study the extent to which the labium had been retracted and so check the results, which were as follows :—

Greatest length of	stylets	protruding	$=6·8$	units.
Least	,,	,,	$=2·6$	,,
Average	,,	,,	$=4·06$	,,

The general results obtained up to this point seem to show that *A. pomi* may not cause the formation of galls, because it is unable to reach the cambium with the stylets.

A. rumicis has since been sectioned *in situ* on apple and is clearly able to reach the phloem and penetrate to a point sufficiently near the cambium to produce galls, had it the power of doing so. This species, from observations up to the time of writing, has been confined chiefly to the petioles and leaves of Northern Spy. On Winter Majetin, the infestation was found only on the extreme tip, but on those stocks which were susceptible, or only resistant, to Woolly Aphis it extended a little further down. *A. rumicis* is therefore found on stocks immune from *E. lanigerum*. It also occurs on portions of immune stocks where *E. lanigerum* could penetrate to the cambium with comparative ease, if the sclerenchyma were the only reason for

immunity, instead of being the factor for resistance only. From this it seems probable that the factors determining immunity of stocks from *A. rumicis*, if such immunity does exist, would differ from the factors of immunity of the same stocks in the case of *E. lanigerum*.

Variation in the Character and Position of the Sclerenchyma, in Relation to the Stylets.

The length of the stylets has been considered in relation to the distance from the bark to the cambium. Variations in the character and position of the sclerenchyma in relation to the stylets will now be considered. No actual proof of the value ascribed to them can as yet be furnished, but the possibility of their value should not be lost sight of. These variations will be briefly dealt with.

(1) There must exist some limit to the flexibility of the stylets. This limit can be expressed as a portion of the smallest possible circle into which the stylets can be looped without fracture, the relative thickness of the stylets being taken into consideration. This limit is of course unknown, but in this connexion it would seem that masses of sclerenchyma with a regularly convex outer surface would be more easily circumvented (fig. 5) than more rectangular masses if set close together (fig. 14).

(2) The more nearly the distance from the bark to the sclerenchyma approximates to the length of the stylets, the less will be the length available for bending round any one mass. If the mass were long and the stylets came against it at the centre, the above consideration might prove of importance.

(3) The extent to which the cells of the collenchyma are thickened, and the distance this tissue extends inwards.

(4) The general compactness of the cortex. It is conceivable that a well-developed collenchyma and a compact cortex may act as an additional hindrance to the insertions of the stylets by the Aphid. The compactness of the cortex, it is interesting to note, may roughly be judged by means of a sharp knife or a razor. If a transverse section be cut by hand of a stem of most of the susceptible varieties, it is felt that the razor passes through the cortex with comparative ease. A slight opposition is noticed when passing the sclerenchyma, but not much resistance is offered until the xylem is reached.

On the other hand, if sections of the stems of many of the resistant and immune varieties be cut, the opposition offered is markedly different, as the razor traverses the cortex with much more difficulty. It will also be found that, during all stages of the cutting, a greater effort is required than in the case of the more susceptible stems. Further, with the resistant stocks, the effort required to cut through the cortex approaches more nearly to that required when the razor passes through the xylem.

(5) It seems probable that a relation exists between the size of the Aphid and the size of the gaps between the masses of sclerenchyma.

The size of an opening may be such that it is impossible for more than one Aphid at a time to pass the stylets through and reach the cambium. Gall formation will therefore be slower than when the opening is large enough to admit the stylets of several Aphids.

The exceptions to the agreement of Tables A and B can be explained to some extent by these five forms of variation, and further enquiry is being made in this connexion. The question will be dealt with more fully in a later paper, when it is hoped that more data will be available.

The importance of the chemical constitution of stocks has not been lost sight of, and ash analyses of Northern Spy and Type I have been made, but little work on this aspect has been carried out. The importance of chemical composition of the

plant and the soil in relation to immunity questions is clearly demonstrated by the results of work on the mosquito blight of tea (*Helopeltis theivora*) by E. A. Andrews (5).

Melting Point of the Wax secreted by the Aphids.

Although no serious attempt has been made yet to discover new methods of control, it was at one time considered that hot sprays might be more effective than those used cold. In this connexion the melting point of the wax, so characteristic of Woolly Aphis, was determined in the hope that it would be low enough to make hot sprays an effective method of control. The melting point of the wax was found by the usual method of placing it in a capillary tube attached to the bulb of a thermometer and heating in water. Colonies of the Aphids were also used. Contrary to all expectations, boiling water failed to melt the wax. It is thought, however, that radiant heat may prove to be more effective and experiments are being carried out on those lines.

Action of the Saliva of the Aphids on Starch.

Blomfield (2) states that the percentage of sugar in the galls is very high and far greater than in the surrounding ungalled tissue. Baker (pt. 1, ref. 4) also states this to be the case. Davidson (1) placed the salivary glands on an agar plate impregnated with starch and treated the plate with iodine, thus showing the conversion of the starch by the action of the saliva.

The present writer impregnated a mixture of gelatine and glycerine with starch; to this mixture was added a little apple juice in such a quantity that, when the mixture was cold, it formed a stiff jelly. Plates of this mixture were used, about an eighth of an inch thick. About a dozen Woolly Aphids were placed on each plate and it was found that they inserted their stylets and fed for 24–36 hours.

The plates were then treated with iodine, with the result shown in fig. 17 (*AI*, *AII* and *AIII*). The clear patches are where the Aphids were feeding, the starch there having been changed into sugar; no change took place on the control, where no Aphids were present. The black backgrounds shown in fig. 17 were, of course, blue in the original. Repetitions of the experiment showed that better definition and contrast were obtained when the starch was boiled with a little water before being added to the glycerine jelly.

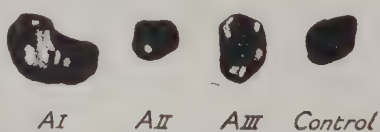

Fig. 17. Illustrating the action of the saliva of the Aphids on starch.

The Selection of Wildings.

In Part I of this paper mention is made of the selection of wild crab apples in a wood in North London. They were selected by the methods already described in this part of the paper. All the four varieties selected (referred to in Part I as S1, S2, S3 and S4) have the following structural characteristics in common:—

(1) A high percentage of sclerenchyma is developed very early.

(2) The cortex is compact and the stem is of a very wiry nature (see page 20 in MSS., No. 4).

(3) The development of a double row of sclerenchyma follows very quickly on the ordinary single row mentioned above (1).

(4) The same characteristics as regards the sclerenchyma apply to the roots to some considerable extent in the above-mentioned wildings. Here it should be noted that the question of sclerenchyma, in connexion with resistance on the roots, has been shown to be of importance to a far less extent than in the case of the aerial portion of the stock. Where, however, the sclerenchyma is present to an effective degree, its importance should not be minimised.

The Relation of the Stylets of the Aphid to the Cells of the Stock.

This question, as might be supposed, is extremely complex. Only the principal facts which affect the problem under consideration will be mentioned here. No discussion on them will be included, as this side of the question will form part of a paper on the stylets of the Rhynchota in relation to plant tissues. The main features are as follows :—

(1) The stylets pass intracellularly through the epidermis.

(2) The stylets then pass on into the collenchymatous and cortical cells ; they pass through the cells intracellularly. Only occasionally are the stylets seen to pass through intercellularly, when it is seen that it is the shortest path that has been taken.

(3) Neither an intercellular nor an intracellular path is possible through a mass of sclerenchyma, so long as it retains its integrity. The stylets therefore pass round ; in this connexion see consideration No. 8.

(4) The salivary track is well defined. Work, by Davidson, on the stylets and salivary track of *Aphis rumicis* should be referred to.

(5) There is present a distinct stylet sheath. This sheath is not more or less continuous (as found, in the case of *A. rumicis*, by Davidson), but is broken up into sections of varying length (fig. 18, *Ss*).

(6) Plasmolysis is marked for some three or four cells on either side of the stylets ; instances where the influence of the saliva has extended further have, however, been observed.

(7) The sucking out of the cells may be intracellular or intercellular, but is more often the former.

(8) The saliva of the Aphid can dissolve away the middle lamella, thus causing the individual cells to break away from one another. This was most frequently observed in the sclerenchyma. This property of the saliva, together with the pressure of the rapidly growing gall, results in the separation of the masses of sclerenchyma into their cellular elements. The salivary track of the Aphid may extend round the mass of sclerenchyma in some cases and so affect the cambium.

(9) The salivary track may be detected in the medullary rays after gall formation has been in progress for a short time.

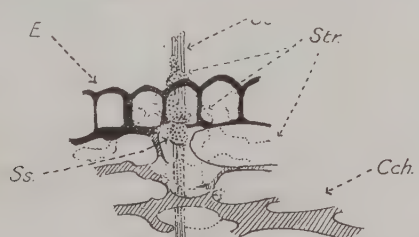

Fig. 18. Stylets of *Eriosoma lanigerum* passing through the epidermis and collenchyma of the young wood of a wild crab apple, as seen in transverse section.

Summary of Results.

1. A short account of gall formation is given.

2. The stylets of *Eriosoma lanigerum* penetrate to within three or four cells of the cambium. Penetration is mainly intracellular, but the stylets cannot pass through the masses of sclerenchyma.

3. When a mass of sclerenchyma is encountered the stylets bend round it ; if they cannot bend round it, they are usually withdrawn.

4. So far as can be seen at present, immunity cannot be explained by mechanical considerations.

5. There is strong evidence for supposing that resistance above ground is directly proportional to the percentage of sclerenchyma round the circumference of the stem.

6. The above statement must be qualified, if necessary, by a consideration of the extent to which the masses of sclerenchyma are broken up, *i.e.* the number of spaces that are available for the penetration of the stylets.

7. The middle lamella can be dissolved by the saliva of the Aphid ; so that the check formed by a mass of sclerenchyma can eventually be overcome.

8. Variations in the character of the sclerenchyma and its position are shown to be of possible importance. There would also seem to be some connexion between the size of the Aphid and the size of the openings between the masses of sclerenchyma.

9. The relations of the stylets and stylet track to the cells of the stock are briefly summarised.

10. Measurements have been made of the stylets of *Eriosoma lanigerum, Aphis rumicis* and *A. pomi* ; also of the length of stylets available for insertion into the tissues of the stock. All three species of Aphids were found feeding on the stocks at Chelsea. The stylets of *E. lanigerum* and *A. rumicis* were found to be long enough to reach a point suitable for the formation of galls. This would point to a difference in the constitution of the saliva of these two species. *A. pomi* has an insufficient length of stylets to penetrate much beyond the middle of the cortex.

11. The melting point of the wax secreted by the Aphids has been shown to be above the boiling-point of water.

12. Starch can be converted into sugar by feeding the Aphids on a plate of glycerine jelly impregnated with it.

References.

The references given below are additional to those already mentioned in Part I of this paper. Moreover, the publications mentioned in Dr. J. Davidson's latest paper (Ref. No. 1) are not included in this list. The literature on Woolly Aphis is too immense to be quoted in full, nor is it necessary for the purposes of this work.

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FACTORS INFLUENCING THE CONTROL OF COTTON-STAINERS (*DYSDERCUS* SPP.).

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Cotton-stainers, *Dysdercus* spp., are most important factors affecting the growing of cotton in the West Indies and elsewhere, on account of the fact that they convey certain bacteria and the spores of various internal boll fungi which cause staining and rotting of the cotton lint.

Many suggestions have been put forward for the biological control of these pests, such, for instance, as the destruction of all alternative host-plants, introduction of parasites, etc. ; but these recommendations, while they may be practicable in small islands and under other favourable conditions, cannot be offered with confidence where cotton is to be grown on a large scale or where the eradication of other Malvaceous plants and the like is impossible financially.

In Trinidad, where the writer has given particular attention to *Dysdercus howardi*, Ballou, it is quite clear that the essence of control lies in recognition of the following two facts. Firstly, *Dysdercus* is not attracted to the cotton plant in any appreciable numbers until the bolls commence to open. This has been observed to be the case even when infested perennial cotton was grown within three hundred yards of a young and flourishing crop of Sea Island cotton. The Sea Island crop remained *entirely free* from *Dysdercus* until the bolls commenced to open, when large numbers of *Dysdercus* appeared. It can be shown that they are attracted by a volatile substance given off at this period from the inside of the boll. This does not mean to say that previously the cotton is not attractive ; it is, but it is not sufficiently so to cause a large influx of *Dysdercus* from a distance.

This brings one to the second essential point, namely, that so far as the cotton crop is concerned, outbreaks of *Dysdercus* in large numbers are traceable to distinct migrations. The migrations are composed largely, and often show a preponderance, of small or dark, or otherwise non-typical forms. In *D. howardi* the migrants are often so extreme as to have black hemelytra and scutellum, but the antennae always show a trace of white banding. The percentage of non-typical forms has been observed to be as great as 62, and may often be greater. This fact is extremely interesting and recalls the work of Uvarov* on the Acrididae, in which he shows that certain varietal forms predominate in locust swarms.

The *Dysdercus howardi* migrants feed and lay eggs in the ground among the cotton crop, and the broods resulting from them are typical, pale, and generally fairly large *D. howardi*. These spread havoc among the still-developing bolls, and the crop may henceforth be considered as almost valueless owing to the spread of internal boll rots transmitted by these pests. The first crop of bolls, which served as the source of attraction to the migrant *Dysdercus*, should prove to be in good condition and almost undamaged, since boll rots cause little injury to bolls when ripe or nearly so, but future bolls, developing under *Dysdercus* conditions, may be so damaged by boll rots as to be not worth waiting for.

Cotton can only be grown in Trinidad under present conditions if the grower is prepared to make all his profits on the first yield and then to plant elsewhere, preferably after having destroyed the infested crop and substituted for it some other, non-Malvaceous, crop. This should prove to be a good economic proposition, and the writer believes that a good return could be obtained, at least in Trinidad. Perennial cottons are useless under Trinidad conditions since the first yield of bolls is not heavy enough and the crop, after the first bearing, harbours *Dysdercus* continuously.

Investigations have been carried out which suggest some of the possible conditions tending to produce migrational forms, but these and other considerations must be left for fuller treatment at a later date.

* Bull. Entom. Res., xii, 1921, pp. 135–163.

FURTHER OBSERVATIONS ON *DYSDERCUS SUPERSTITIOSUS*, F., AND OTHER INSECTS AFFECTING COTTON IN SOUTHERN NIGERIA.

By A. W. J. Pomeroy, M.B.E.

(Plates II–V.)

The object of this paper is to give a résumé of the continued experiments with regard to the various phases of the damage to the cotton crop of the American variety, Allen, grown on Moor Plantation, Southern Provinces, Nigeria, by stainer-bugs of the genus *Dysdercus*, with special reference to the external and internal evidence of injury by this agency as compared with that caused by other insects.*

The nature of stainer injury on cotton bolls has been observed and commented on by several authors, but when this is complicated by other insect injuries the diagnosis is more difficult. It is hoped that these records and illustrations will be of some assistance to future workers.

In the following experiments the buds and bolls on cotton plants in the field were confined in small individual cages made of hoops of tin, covered with a muslin of a mesh such as to exclude any insects, though possibly not Acarine mites, and yet of a transparency so that sufficient light and air were present. The hoops were affixed to a stout stick, on a cross-bar, and the stick firmly fixed in the ground so that the ends of the bag could be opened without injuring the boll by any undue pressure on the stem. As young bolls are prone to shed with very little handling, it is most important that there should be no strain on the stem carrying the boll. The leaf adjacent to the boll was included in the cage.

The following table gives the results of experiments in which stainers were introduced into the cage. The buds were screened before they showed signs of opening,

Table showing the Results of Introducing Adult Dysdercus superstitiosus ♀ *on to Young Bolls.*

Number of days from stainer introduction to first puncture seen.	Number of days from first puncture to shedding of boll.	Number of days from stainer introduction to shedding of boll.	Number of punctures.	Evidence of internal proliferations.	Evidence of internal boll disease.	Remarks.
6	—	—	14	Yes.	Yes.	55 days to opening of boll; all four locks aborted and stained; typical boll disease.
4	3	7	3	Yes.	Yes.	Seeds aborted and watery; opened prematurely.
1	4	5	1	No.	No.	Seeds aborted, but not watery.
1	1	2	3	No.	No.	Boll withered (accidentally broken off).
1	3	4	5	Yes.	Yes.	Seeds aborted, watery and yellow.
2	3	5	1	No.	No.	Seeds aborted, but not watery.
2	3	5	3	Yes.	No.	Seeds aborted, but not watery.
1	3	4	2	Yes.	No.	Seeds aborted, but not watery.
2	2	4	2	No.	No.	Seeds aborted, but not watery.
3	10	13	10	Yes.	Yes.	Seeds aborted, watery; lint stained; evidence of typical internal boll disease.

* A. W. J. Pomeroy & F. D. Golding. Second Annual Bulletin of the Agricultural Dept. Nigeria, 1923, pp. 23–58.

and one adult ♀ *Dysdercus superstitiosus* was introduced as soon as the boll was formed and the flower petals shed. All other buds and bolls on the plant were removed to avoid complication by possible physiological shedding. If a stainer died, another was at once put in to replace it. The object of these experiments was to ascertain the average period of days at which the young boll would be shed after being punctured, the daily number of punctures, and the nature of the resultant injury with regard to internal proliferation and evidence of internal boll disease.

It will be seen from this table that eight of ten bolls were shed from stainer injury and that the average number of days from first puncture to shedding was 3·8. The average number of punctures per day was between 7 and 8. Five showed very definite internal proliferations, but in the case of the three which showed no internal proliferation, it was found on sectioning that the rostrum had pierced the carpel wall and that the bolls had been shed before proliferation commenced.

The interior of six bolls did not show the characteristic signs of internal boll disease, though the seeds were shrunken and withered, and microscopic examination by the Mycologist, Mr. T. Laycock, failed to produce any evidence of the organisms definitely known to be associated with internal boll disease. There seems little doubt that shedding can be caused by the mechanical action of the stainer alone, without the introduction of boll disease, when the bolls are at a very early stage of growth.

The single boll which was not shed in this experiment prematurely opened in the field. The locks were aborted, the lint stained brown and the interior proliferated. The seeds had not developed properly and the general condition was typical of stainer injury combined with internal boll disease (Plate v, fig. 1, lower row).

Of the ten experiments with stainers introduced before the buds had opened, and the stainer removed before the flower petals were shed, three bolls developed typical stainer injuries. One was shed after five days, and the other two opened prematurely after 31 and 46 days respectively. All three showed internal proliferations, and two evidences of boll disease, the lint being stained and the seeds aborted. Six of the bolls developed normally, showing that no puncturing had taken place. One was destroyed by a small *Earias* larva, which had developed from an unnoticed egg laid on the flower bud.

It is evident that the stainer is capable of causing shedding, or that boll disease may be introduced, while the cotton is in the flowering stage.

Twenty control experiments were carried out, in which the bolls were screened from insect attack before the buds had opened, with the result that all bolls developed normally except two. One was attacked by an *Earias* larva, as before, which developed from an egg overlooked on the bud, the other was shed through either possible physiological causes or, as observed from the condition of the stem, more probably on account of injury due to handling during examination (Plate v, fig. 1, top row).

With regard to the external evidence of stainer puncturing, the puncture can be detected within half an hour by the presence of a small bead of moisture, which exudes from the canal made by the rostrum. After a day or so the area around the orifice of the puncture becomes blackened and is seen to be composed of a cork-like substance. The area may be proliferated externally to some extent (as in Plate ii, fig. 1) or remain flat (as in Plate iii, fig. 1, A) ; but even with a low power lens, a minute orifice can be observed centrally in nearly every instance where the rostrum has pierced. The injury caused by the "nibbling" of a small Lepidopterous larva, such as *Prodenia litura*, in its early stages, though superficially resembling stainer puncturing, can be distinguished by the irregularity of the "corked" area, as compared with the stainer puncture, and by the absence of the minute orifice of the central canal (Plate iii, figs. 1, B, 2).

Unless the injury extends through the carpel wall, no internal proliferation is produced, and the boll may develop normally, even though showing numerous markings and scorings externally, resembling stainer punctures. Of eight experiments in which young *Prodenia litura* larvae were introduced on screened bolls, three were bored by the larvae so that the interior was destroyed, three were partly injured so that two or three locks only developed, and two, though scored and marked on the exterior, developed normally with strong unstained lint (Plate v, fig. 2).

Five experiments were made to ascertain the effect of stainer injury and *P. litura* injury combined. In four cases, three showed typical injury by both and also internal boll disease. One showed only *P. litura* "nibblings" without the carpel wall being pierced. The stainer died without puncturing the boll, and the *P. litura* larva died without piercing the carpel wall, with the result that the boll developed normally, with no stained lint or internal proliferation.

Aphids were occasionally present, and it has been definitely proved by repeated experiment that, though Aphids retard the growth of the boll and the fibre of the lint becomes weakened in certain cases, yet they do not pierce the carpel wall and introduce internal boll disease.

The injuries by the bollworms, *Earias* species and *Diparopsis castanea*, are readily diagnosed. The boll is almost invariably bored through and the interior destroyed (Plate iv, figs. 1, 2).

Stainer injury on native African cottons, Ishan and Meko varieties, is much more difficult to diagnose than that on American cottons, as the surface of the bolls is greatly pitted and the oil glands and fat bodies are very prominent. The slightest abrasion will cause these fat bodies to exude moisture. The same rule holds good, however, with regard to general diagnosis as in American cottons, but the evidence of fresh punctures is not so apparent for the reasons stated.

Internal proliferation may be caused by young bollworms, especially *P. litura*, which may not bore into the interior yet pierce the carpel wall. These proliferations are distinctly irregular and unlike the more symmetrical protuberance of the proliferation caused by stainer puncturing. If several stainer punctures occur close together, the proliferation may become merged. The internal proliferation may not be always exactly opposite to the external wound, as the rostrum is sometimes inserted at an acute angle. For this reason proliferation may be noticed by an inexperienced observer which has no apparent external origin, but if the carpel wall is carefully sectioned, in every instance the canal leading from the proliferation to the exterior will be found.

Summary.

Young bolls may be shed owing to the mechanical action of stainer puncturing, apart from the introduction of any specific internal boll disease. One puncture is sufficient to obtain this effect.

Unless the carpel wall is pierced, no injury to the boll from insect attack results, and it is highly probable that the piercing of the carpel wall is essential for the introduction of internal boll disease.

Internal proliferation does not take place unless the carpel wall is pierced, and is not an essential factor in the shedding of young bolls, but rather an indication of injury from an external source.

Puncturing by stainers of the buds and flowers, before the flower petals have fallen off, may cause the shedding of the boll and the introduction of internal boll disease.

The surest superficial diagnosis of stainer injury to bolls, as compared with other insect injuries, is the finding of a bead of moisture exuding from the single minute orifice, in the case of a fresh puncture, and of a minute canal in the centre of the

corked area of an injury some days old. The regularity of the rim of the corked area is a strong indication of stainer injury, the periphery of the corked area produced by the nibbling of young Lepidopterous larvae being irregular, owing to the action of the mandibles.

The result of experiments for two seasons on American cotton on Moor Plantation, Southern Provinces, Nigeria, has proved so far that cotton bolls that have been screened and kept free from insect attack do not develop the symptoms of internal boll disease, or the condition described in this paper as being typical of stainer or bollworm injury. These insects are the principal cause of damage to cotton bolls in Nigeria, either by direct mechanical action or by introducing bacterial and fungous disease.

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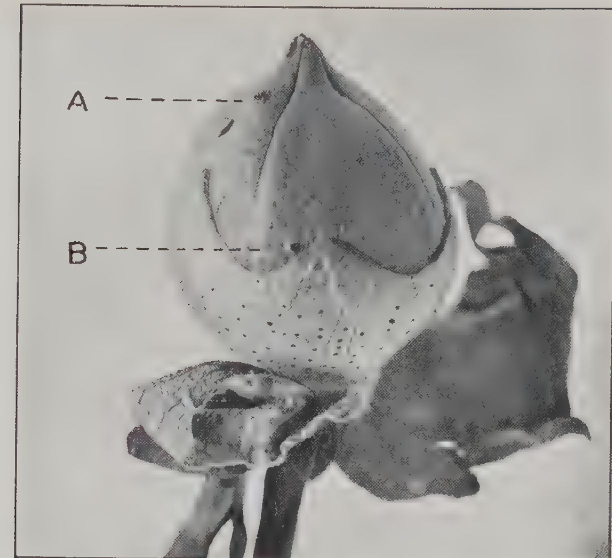

Fig. 1. Typical injury on young boll (Allen cotton) by *Dysdercus superstitiosus;* external proliferated punctures at A and B. × 2.

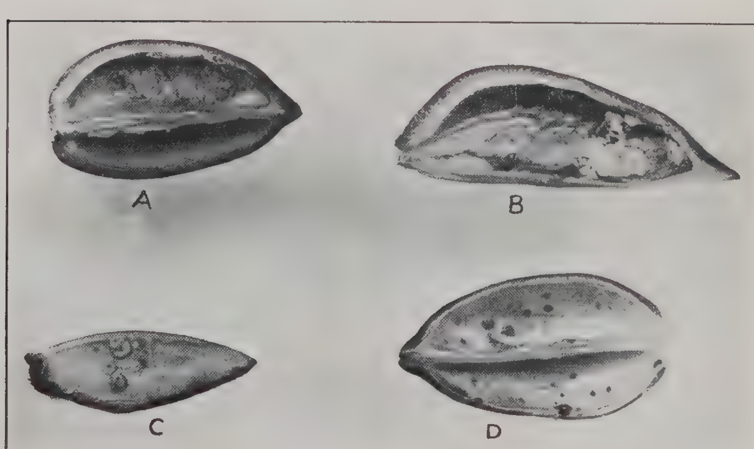

Fig. 2. Proliferations in interior of young cotton bolls (Allen): A, result of several punctures by stainers; B, proliferation caused by small larva of *Prodenia litura* and a stainer; C, typical stainer injury, the dark spot in centre being the orifice of the puncture; D, result of stainer attack in early stage of growth, appearing as translucent green excrescences.

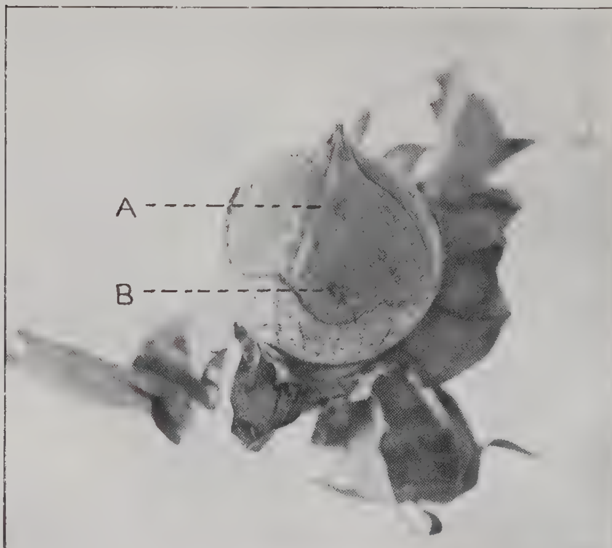

Fig. 1. Young boll (Allen variety) showing A, typical puncturing by *Dysdercus superstitiosus*, and B, nibbling by young larva of *Prodenia litura*; boll shed, but no internal proliferation. × 2.

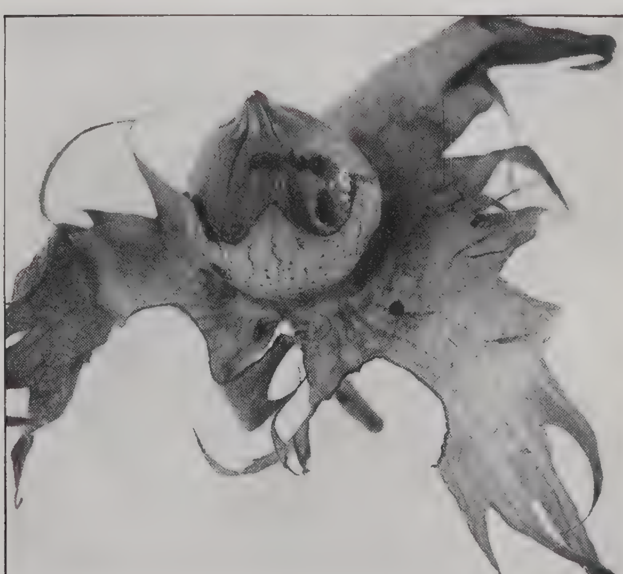

Fig. 2. Young boll (Allen) showing typical injury by young larva of *Prodenia litura*, in this instance penetrating the carpel wall. × 2.

Fig. 1. Young boll (Allen) with larva of *Diparopsis castanea* boring into it. Natural size.

Fig. 2. Young flower bud (Allen), with larva of *Earias biplaga* boring into it. × c 3.

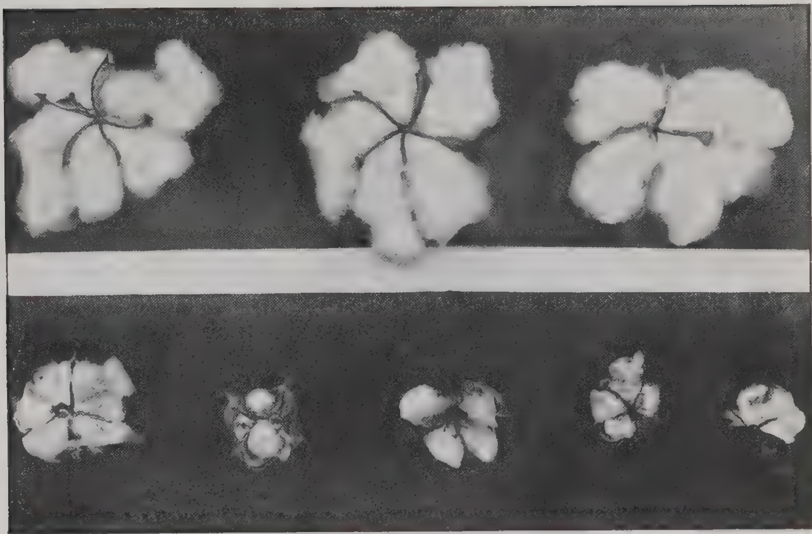

Fig. 1. Top row: typical average bolls (Allen), obtained by screening from all insect attacks. Lower row: typical bolls (Allen) that have opened prematurely and become aborted as a result of attack by stainers.

Fig. 2. Ripe boll (Allen), with lint and seed normal, showing marks made by larvæ of *Prodenia litura* when boll was forming; the injuries did not extend through the carpel wall. A little less than natural size.

OBSERVATIONS ON THE ABILITY OF LARVAE OF *ANOPHELES MACULIPENNIS*, MG., TO CRAWL.*

By V. V. Nikolsky,

Entomologist of the Moscow Tropical Institute.

My observations in 1923†, and more particularly in 1924, made both in nature and in the laboratory, have proved that larvae of *Anopheles maculipennis*, Mg., are able to crawl quite actively and, under certain conditions, may wander from one pool to another.

The ability of the larvae to crawl may be proved very easily; if they are placed on a sheet of blotting-paper, saturated with water, they begin to crawl about after 2–3 minutes' time.

When crawling on a moist surface (soil, blotting-paper, etc.) the larvae use their oral appendages, particularly those of the labrum, as points of support; at the same time the abdomen makes peculiar peristaltic movements, beginning from the 8th segment. Usually during the first few minutes of crawling the anterior ventral bristles of the thorax break off, and the tubercles on which the bristles are placed, together with the basal parts of the broken bristles, form something like pseudopodia. These tubercles, even when the bristles break off at the very base, to a certain extent help the larvae to crawl.

Larvae can crawl on any surface which does not absorb water from them too quickly. Thus, they may crawl for some time on glass, linoleum, etc. If a larva meets on its way an object absorbing water, as, for instance, dry blotting-paper, or if a larva crawling on moist soil encounters a dry patch, it suddenly alters the direction of its movement.

Larvae can crawl on horizontal, sloping and vertical surfaces, and they can crawl over small hillocks. On encountering plants, larvae occasionally crawl up their stems; I have observed cases in which a larva climbed up a stem to a height of two centimetres.

The ability to crawl has been observed in larvae of all stages, even the first. The velocity of the movement depends, however, partly on the age, the larger larvae moving more quickly, and also on the character of the surface, particularly on the degree of its dampness, and whether it is moistened evenly or in patches. Larvae often do not crawl straight ahead, but make zigzags and loops and sometimes completely reverse their direction.

It cannot be stated definitely that the larvae always crawl towards water, but as far as my observations go, the direction of movement is determined by the differences in the dampness of the surface and by the positive hydrotaxis of the larvae.

The velocity of larvae of the first stage, under approximately natural conditions, and with the temperature of the surface at 27° C., varies between two and six centimetres in the first hour. The speed attained by larvae of the 4th stage, under the same conditions, is about ten to thirty-six centimetres in the first hour. The crawling alternates with stoppages; thus, one larva, observed under the same conditions and at a temperature of 19° C. during 54 minutes, crawled for 42 minutes altogether, and rested for 12 minutes.

During the first hour the larvae move more quickly, while after that they rest more often and for longer periods. Under laboratory conditions, when the surface on which the larvae crawled was extremely moist, and with many small pools of water, larvae of the last stage have wandered for 28 hours. On the whole, the duration of movement depends on the drying up of the surface.

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* Translated from the Russian manuscript by B. P. Uvarov.

† Russian Journal of Tropical Medicine, 1924, No. 2, p. 44.

The maximum distance covered by a larva actually observed under natural conditions was 75 cm., and in the laboratory 106 cm.; in both cases the soil which the larvae traversed was very moist and with small pools of water.

The wandering of larvae for short distances, 2–5 cm., is a very usual occurrence during the drying-up of certain pools, at any rate, in the Moscow Government, but wandering for longer distances (up to 75 cm.) has been observed in nature only on a few occasions. One such case I saw in the middle of June 1924, near Moscow. The pools, where the observations were made, usually dry up in the middle of summer; they served as watering-places for cattle, and water collected in the hoof-prints, other small puddles forming simply as a result of the drying up of the main pool. As these small collections of water dried up one by one, the larvae crawled from them to the nearest puddles still containing water; some larvae managed, in this way, to reach the main pool. The temperature of the water in this case reached 36°C., but I have made similar observations at temperatures of 18°C. and 20°C.

In another case I saw wandering larvae when the water from a small pool had been let out by a drainage-trench; the larvae moved in this instance, in the direction of the flow of water, and distinctly selected more low-lying portions of ground.

Turning to the probable importance of the ability of mosquito larvae to crawl we may assume that it certainly helps some larvae to escape death, when pools are drying up. Certain other adaptations serve the same purpose. Thus, my observations have shown that *Anopheles maculipennis* emerge from pupae even when the latter were not in water, but simply lying on moist soil, amongst debris. Larvae are also able to withstand drying up to a certain extent; thus, under the Moscow conditions, they live on moist soil up to three days if the weather is cloudy, and for one day if it is sunny. The ability of larvae to develop more quickly the higher the temperature is also beneficial to the species, since usually the warmer pools are those which are drying up. In the vicinity of Moscow, in June 1924, the whole life-cycle of *A. maculipennis* was 13–14 days in small drying-up pools, and 30–35 days in ponds.

It is obvious that the ability of larvae to wander must be useful for the preservation of the species, but its utility is somewhat limited, since only relatively small distances can be covered and that only on very damp soil. However, it is not impossible that in some other species of mosquitos this capacity is more strongly developed, and correspondingly of more importance for the species.*

I may add also that larvae of *A. maculipennis* when crawling are subject to attacks by carnivorous flies, *Lispa uliginosa*, Fall. (named by Mr. Smirnov, of the Moscow Zoological Museum), sometimes to the extent that only very few of the larvae manage to reach the next puddle. The fly seizes a larva and flies off with it, settling on some plant where it sucks out its prey.

J. O'Connor * This is believed by ~~Dr. P. H. Manson-Bahr~~ to be the case with *Aëdes (Finlaya) kochi*, Dön., in Samoa (*vide* Res. Mem. London School Trop. Med. iv, 1923; abstracted in R.A.E. xi, B, p. 90).—F. W. Edwards.

A FURTHER NOTE ON AFRICAN CERATOPOGONINAE.—II.*

By A. Ingram and J. W. S. Macfie.

The descriptions given below of two species of *Atrichopogon* and some remarks made upon the variability of *Culicoides inornatipennis*, C.I. & M., as it occurs in the Gold Coast, complete the account of the examination of the collection of African Ceratopogonine midges, kindly placed at our disposal by the Director of the Imperial Bureau of Entomology, to whom we are greatly indebted for this privilege.

We have taken the opportunity to include here a description of a species of *Ankistrodactylus*, which has recently come into our possession, and we have added also records that appear to be new of the distribution of *Culicoides inornatipennis*, of *Culicoides grahami*, Aust., and of *Culicoides fulvithorax* (Aust.).

The unit referred to in the description is approximately 3·7 μ.

Atrichopogon hirsutipennis, I. and M.

Length of body (one male), 1·9 mm.; length of wing, 1·6 mm.; greatest breadth of wing, 0·4 mm.

Head very dark brown. Eyes almost bare, but with a few hairs near the margin; broadly contiguous above, the facets separated by a narrow line. Clypeus, proboscis, and palpi dark brown. Palpi with the second, fourth, and fifth segments subequal, about twice as long as broad; third long and slender, about as long as the fourth and fifth together, inflated only slightly, and furnished with a small sensory pit. *Antennae* dark brown, with large dark brown plumes; torus darker than the flagellum segments. Third segment smaller than the fourth, with a stalk, length and breadth about 19 and 10 units respectively. Segments 4 to 11 all of about equal lengths (12 units), but gradually narrowing from about 12 units in the case of the fourth to about 8 units in the case of the eleventh; large spines not very stout, almost straight, tapering to pointed extremities; whorls of hairs almost transverse on all the segments. Segment 12 like segment 11 but more elongated distally, measurements about 19 by 7 units. Segments 13 to 15 more elongated; 13 and 14 slightly expanded basally, measuring in length and basal breadth about 35 by 6, and 30 by 6 units respectively; the last segment rather broader, about 33 by 7 units, and ending in a short stylet (about 12 μ). The combined length of segments 12 to 15 (117 units) greater than that of segments 4 to 11 (87 units) or 3 to 11 (107 units). *Thorax* dark brown. Dorsum with a narrow admedian line of a pale brown colour on each side which expands into a rounded spot anteriorly, and ends posteriorly at a small oval pale spot (fig. 1, A). Pleura dark brown. Scutellum as in the female; bearing two lateral and two centro-marginal bristles, and about 12 short hairs. Post-scutellum very dark brown. *Wings* (fig. 1, B) longer and narrower than in the female, pale brownish; densely clothed with the usual rather large microtrichia, and bearing on the distal quarter also some macrotrichia. Macrotrichia not so abundant as in the female, distribution as follows:—a number near the apex of the wing anterior to the fourth vein, a few near the periphery of the wing between the rami of the fourth vein, a few along the distal parts of the rami of the fourth vein and anterior ramus of fifth vein, none elsewhere. Venation similar to that of the female. Costa reaching about two-thirds the length of the wing (57 : 87). First radial cell small, slit-like; second longer and broader, but not so long as in the female. Bifurcation of the fifth vein at about the level of the middle of the proximal radial cell; anterior ramus ending distal to the level of the end of the costa, posterior proximal to this level. Fringe short, of the usual form. Halteres with white or cream-coloured knobs. *Legs* yellowish brown, tarsal segments somewhat darker

* For Part i, see this Bulletin, xiv, 1923, pp. 41–74.

than the rest; clothed with short hairs. First tarsal segment about three times as long as the second on all the legs, namely 3·2, 3, and 2·7 times on the fore, middle, and hind legs respectively. Terminal tarsal segments sub-cylindrical. Claws equal, simple, slender, about half the length of the fifth tarsal segment, with bifid ends. Empodium long and hairy. *Abdomen* darkish brown, sparsely clothed with dark hairs. *Hypopygium* (fig. 1, C to E). Ninth segment dark brown; tergite not very long, rounded posteriorly, well covered with stout hairs; sternite very slightly excavated

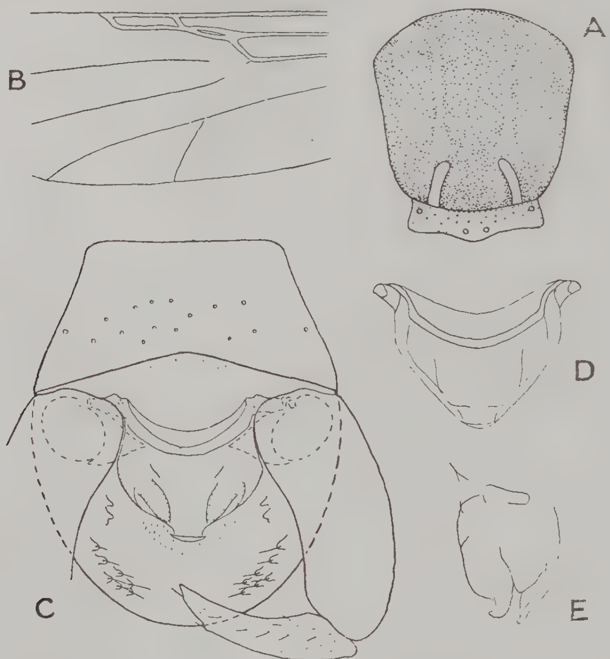

Fig. 1. *Atrichopogon hirsutipennis*, I. & M., ♂: A, thoracic adornment; B, middle part of wing to show venation; C, hypopygium, ventral view; D, detached aedoeagus, ventral view; E, the same, lateral view. (A and B ×c.60, the others ×c.300).

in the middle line posteriorly, bearing about 15 to 20 hairs. Forceps well chitinised; claspers shorter than the side-pieces, darkish brown, almost completely covered with minute hairs intermixed with which are a few longer hairs. Aedoeagus in ventral view as shown in the figures (fig. 1, D, E); very similar to that of *A. homoius*. A few minute spicules are present at the anterior margin of the membrane joining the aedoeagus to the ninth sternite.

NYASALAND: Zomba camp, x.1911, 1 ♀ and 6 ♀♀ (*Dr. H. S. Stannus*).

This insect resembles *A. hirsutipennis*, a species described from a single female taken at Mossel Bay, Cape Province, and is described here as the male of that species because Dr. Stannus' specimens included one female *A. hirsutipennis* together with the six males, all taken at the same time and in the same locality. The male differs from the female rather notably, but probably only sexually, in the hairiness of the wings and the venation, and in some respects resembles the male from East Africa described by Kieffer as *A. anemotis*, but it is impossible to decide at present if the two are or are not identical.

Atrichopogon stannusi, sp. n.

Length of body (two females), 1·5 mm. ; length of wing, 1·3 mm. ; greatest breadth of wing, 0·45 mm. A brown midge with three dark brown longitudinal stripes on the dorsum of the thorax, and an almost black spot just anterior to the middle of the scutellum. The West African specimen is rather smaller than the two from East Africa.

Head very dark brown. Eyes densely hairy ; contiguous above, the facets separated by a narrow line. Clypeus, proboscis, and palpi darkish brown. Palpi with the second and fourth segments sub-equal, the fifth slightly shorter and broadly united with the fourth, the third the longest but only a little longer than the fourth, inflated in the middle and furnished with a small sensory pit. *Antennae* darkish brown. In dry specimens the torus appears paler than the flagellum. Torus sub-spherical ; third segment larger than the fourth, with a short stalk. Segments 4 to 10 oval, from about 10 by 8, to 12 by 7 units ; long spines not stouter than the hairs, curved only slightly, with pointed ends ; whorls composed of about 6 or 7 hairs which are short, less than twice as long as the segments. Segments 11 to 15 elongated, sub-cylindrical, 11 to 14 measuring about 22 by 5, 24 by 5, 27 by 5, and 27 by 5 units respectively, the last segment longer, about 44 units, tapering distally and ending in a long slender stylet (about 8 units, or 30 μ). The combined length of segments 11 to 15 (146 units) nearly twice the length of segments 4 to 10 (74 units) and much greater than that of the segments 3 to 10 (87 units). *Thorax* rather pale brown, but with three broad, dark brown, longitudinal stripes on the dorsum, the lateral ones deficient anteriorly, the middle one deficient posteriorly, but followed, just in front of the middle of the scutellum, by a rounded, almost black, spot. More laterally on each side is a somewhat paler brown and shorter longitudinal stripe. The shoulders are light coloured. On each side of the very dark spot, immediately anterior to the sides of the scutellum, is an oval clear area. Pleura brown. Scutellum pale yellowish brown ; bearing two lateral and two centro-marginal bristles which are very dark, and two small hairs. Post-scutellum brown. *Wings* (fig. 2) pale brownish,

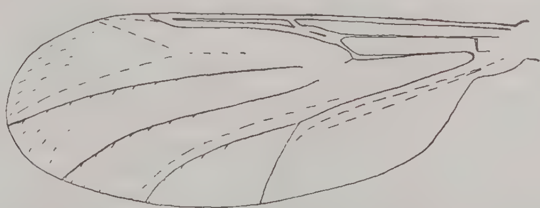

Fig. 2. *Atrichopogon stannusi*, sp. n., ♀, wing, ×c.60.

densely clothed with the usual rather large microtrichia, and bearing a few macrotrichia at the tip of the wing. The macrotrochia lie mostly near the wing margin, and are most numerous between the end of the costa and the anterior ramus of the fourth vein. A few are present, however, between the rami of the fourth vein, at the extreme periphery between the fourth and fifth veins, and along the distal parts of both rami of the fourth vein and the anterior ramus of the fifth vein. Fringe as usual. Costa reaching two-thirds of the length of the wing (53 : 75). First radial cell slit-like, almost obliterated ; second long and narrow. Bifurcation of the fifth vein at about the level of the base of the second radial cell ; anterior ramus reaching the wing margin almost at the same level as the end of the costa. Halteres with pale yellowish knobs. *Legs* yellowish brown, hairs short. First tarsal segment about three times as long as the second on the fore and middle legs (3·1 and 3·6 times in the Kumasi specimen, 3·5 and 3·6 in the Zomba specimen), and rather shorter (2·5 or 2·7 times) on the hind legs. Fifth tarsal segment of the hind legs rather longer

than the fourth. Claws equal, simple, stout, a little thickened in the middle, rather more than half the length of the last tarsal segment. Empodium as usual. *Abdomen* darkish brown, not so yellow as the rest of the body; hairs sparse and short. Spermatheca single, highly chitinised excepting at the extreme base where it merges with the duct, oval but slightly drawn out towards the duct basally, large, about 115 μ by 75 μ, with a number of small, rather indistinct, clear spots near the base.

GOLD COAST: Kumasi, 28.iv.1918, 1 ♀ (*Dr. A. Ingram*).

NYASALAND: Zomba camp, x.1911, 2 ♀♀ (*Dr. H. S. Stannus*).

A. nilicola, K., an insect found in the Sudan, of which at present only the male is known, apparently resembles the species described above in general colouration and wing venation, but lacks the three longitudinal stripes on the dorsum of the thorax, and presumably (since Kieffer assigns it to the genus *Atrichopogon*) has bare eyes; *A. kribiensis*, K., an insect found in the Cameroons, has three longitudinal stripes on the thorax, but the eyes are presumably bare (for the reason given above) and the antennal segments are shorter, the combined length of segments 11 to 15 being one-third, instead of about two-thirds, longer than that of segments 3 to 10; and *A. callipotami*, M., an Egyptian species, is larger and has a longer costa and more hairy wings.

Ankistrodactylus corsoni, sp. n.

Length of body (one male) 3·0 mm.; length of wing, 1·6 mm.; greatest breadth of wing 0·6 mm.

Head very dark brown, almost black. Eyes bare; rather widely separated above by a wedge-shaped area, the facets about 55 μ apart. Clypeus, proboscis, and palpi darkish brown. Proboscis short. Palpi (fig. 3, A) very short, about as long as the proboscis; the segments short and broad, the last four progressively diminishing in size, the third without a sensory pit but bearing a few long sensory hairs on its anterior margin. Sensory hairs slightly expanded at their ends but not clearly drumstick-shaped. *Antennae* brown, the last three segments darker than the rest. Plume small, composed of light brown hairs. Torus large, dark brown, hollowed out in the middle anteriorly. Third segment larger than the fourth, with a long petiole. Segments 4 to 10 sub-equal, barrel-shaped, from once and a-half to nearly twice as long as broad, *i.e.*, from 15 by 11 to 15 by 9 units, each bearing about 14 hairs which do not form a regular whorl. Segments 11 and 12 a little longer (18 and 22 units). Segments 13 to 15 definitely elongated, measuring about 29, 38 and 46 units in length, and 6 or 7 units in greatest breadth; the last segment tapers distally and ends in a conical process without a stylet. The combined length of segments 12 to 15 (135 units) slightly greater than that of segments 4 to 11 (123 units), but less than that of segments 3 to 11 (154 units). *Thorax* uniformly very dark brown (spirit specimen). Pleura very dark brown. Scutellum very dark brown; bearing a few small black bristles and hairs. Post-scutellum very dark brown. *Wings* rather short; brownish, especially near the anterior border and in the neighbourhood of the cross-vein. Anterior veins darkish brown. Wing surface closely covered with rather small microtrichia, but without macrotrichia. Fringe short, on the posterior border composed of a single row of hairs. Costa reaching much beyond the middle of the wing (75 : 90), its end nearer to the tip of the wing than is the end of the anterior branch of the fifth vein, but not so near as the posterior branch of the fourth vein. Two large radial cells, the second about twice as long as the first (internal dimensions). Cross-vein short and not oblique. Fork of the fourth vein a little proximal to the cross-vein, that of the fifth vein slightly distal to this level. Halteres with brown knobs. *Legs* clothed with shortish hairs. Basal segments dark brown. Femora dark brown excepting the basal third which is paler brown; somewhat swollen in the distal half, especially on the

fore-legs. All the femora armed distally with short, stout, black spines: an irregular row of 12 on the fore legs, four on the middle legs, and three or five on the hind legs. Tibiae entirely dark brown on all the legs. First four tarsal segments pale brown, fifth entirely dark brown; the first segment longer than the second, on the fore, middle, and hind legs, 1·7, 2·1 and 2·3 times as long respectively, fourth cylindrical, fifth longer than the fourth, unarmed. Claws dark brown, strong, equal, about half the length of the fifth tarsal segment, with bifid ends. Empodium rudimentary. *Abdomen* dark brown, slender, very sparsely hairy. *Hypopygium* (fig. 3, B) dark brown. Ninth segment: tergite with four strong hairs in a transverse row distally, cleft posteriorly, each half conical and ending in a long, strong, bristle; sternite reduced to a narrow strip of chitin. Forceps:

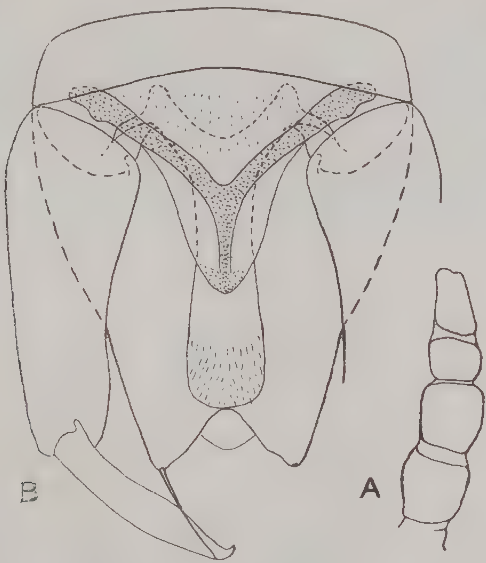

Fig. 3. *Ankistrodactylus corsoni*, sp. n., ♂: A, palp, × c.400; B, hypopygium, ventral view (aedoeagus partly shaded), × c.265.

side-pieces long, tapering distally, moderately hairy; claspers dark brown, highly chitinised, shorter than the side-pieces, densely clothed with small hairs to their ends, bearing also a few longer hairs of which one or two are exceptionally large, and ending in strong claws. Harpes very strongly chitinised basally, similar to those of *A. telmatoscopus* but with the median posterior process broader, tapering gradually, and with a rounded end, the posterior third bearing numerous small, fine, hairs. Aedoeagus conical in ventral view, its highly chitinised parts shaped like a letter Y with a short stem and long, widely divergent arms; the membrane joining the aedoeagus to the ninth sternite is covered with spicules.

Gold Coast: Sekondi, vi. 1922, 1 ♂ (*Dr. J. F. Corson*), taken in a bungalow.

This species resembles closely *A. telmatoscopus*, I. & M., but the genitalia are entirely different, although of a similar type.

Culicoides inornatipennis, C.I. & M.

Gold Coast: Turu, 15.v.1918, 6 ♀♀; Tanina, 1.vii.1918, 3 ♀♀; Kulmasa, 22.vii.1918, 5 ♀♀; Tuna, 23.vii.1918 2♀♀; Mankoma, 24.vii.1918, 5 ♀♀; Sakpa, 28.vii.1918, 9 ♀♀; Mallowe, 29.vii.1918, 2 ♀♀; Banda 'Nkwanta, 30.vii.1918,

6 ♀♀; Jugboi, 1.viii.1918, 6 ♀♀; Bjere, 2.viii.1918, 3 ♀♀; Kukuma, 7.viii.1918, 11 ♀♀; Sekodumase, 8.viii.1918, 2 ♀♀; Chechewere, 9.viii.1918, 1 ♀; (*Dr. A. Ingram*), taken on the arms in the act of biting.

The specimens from Jugboi and from one or two of the other villages in the Northern Territories differ from typical examples of the species in having the wings less hairy, the macrotrichia not reaching to the base between the fourth and fifth veins, but only a little beyond the level of the cross-vein, and scanty (or absent) between the rami of the fifth vein and in the anal angle. The scutellum bears two lateral and two centro-marginal bristles, and four to seven hairs. The characteristic thoracic markings are in some specimens very obscure and the halteres may have creamy-white knobs.

Culicoides grahami, Aust.

GOLD COAST: Kwahu-Prasu, 20.iv.1918, numerous ♀♀; Joasu, 21.iv.1918, 2 ♀♀; Sekodumase, 8.viii.1918, 3 ♀♀; Chechewere, 9.viii.18, 6 ♀♀; Kwaman, 10.viii.1918, numerous ♀♀: (*Dr. A. Ingram*), taken on the arms in the act of biting.

Culicoides fulvithorax (Aust.).

GOLD COAST: Sekondi, vii.1922, 1 ♀ (*Dr. J. F. Corson*), taken in a bungalow.

NOTE ON THE OCCURRENCE OF A HERPETOMONAD IN *GLOSSINA MORSITANS.*

By Ll. Lloyd, D.Sc.

In a recent number of this *Bulletin*, Lloyd and Johnson (1) attempted to describe and illustrate all the known types of flagellate infections encountered in *Glossina*. Since this account was written a flagellate, which it is believed has not previously been described, has been encountered in three individuals of *G. morsitans* at Sherifuri, Northern Nigeria. In the first two cases the worker at the microscope was new to the infections of tsetse and did not notice anything peculiar about the parasite in the proboscides that were being examined. The appearance of the parasites in the stained film caused one slide to be retained with a note, but it was at that time regarded as an aberrant *T. vivax* infection. In the second instance *T. vivax* was present, and the unusual forms accompanying it were remarked upon, but unfortunately the slide was not retained. In the third instance it was noticed in the fresh preparation that none of the parasites were fixed to the labrum, as are the vast majority of those in *T. vivax* infections, nor were they clumped as in this species and in *T. congolense.* Each individual was free-swimming and many were escaping from the labial cavity, the power of translatory movement being great. The hypopharynx was not invaded. The remainder of the fly was then examined and the mid gut was found to be heavily infected, while the salivary glands were negative.

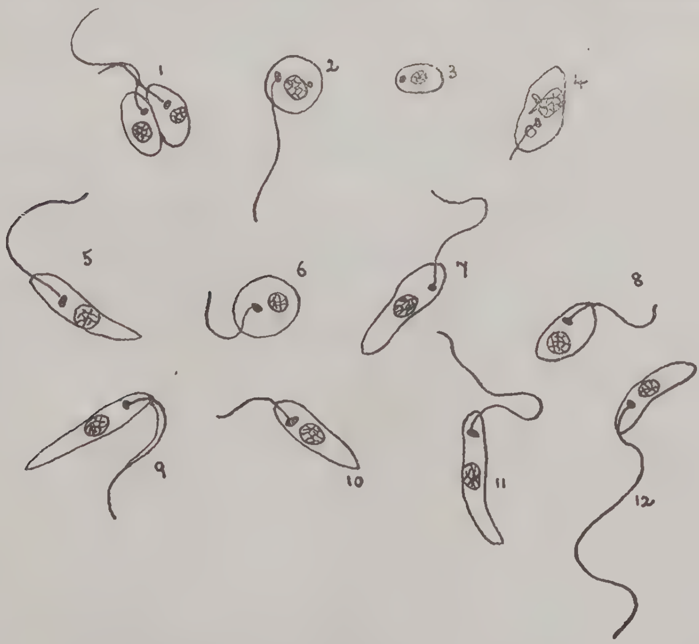

Fig. 1. Herpetomonad occurring in *Glossina morsitans*: nos. 1–8, from the mid-gut; nos. 9–12, from the labial cavity—×2,000.

The parasite (fig. 1) is a herpetomonad, and by the characteristics which distinguish this group of flagellates from trypanosomes and crithidia it is readily distinguished from the known protozoan parasites of tsetse-flies. There is very rarely an undulating membrane, only two out of the many examined having this

at all developed (fig. 1, 9); the kinetonucleus is conspicuous and unusually large, sometimes appearing to be nearly half the size of the trophonucleus; in the proboscis all the forms are free-flagellated and in many individuals the flagellum is of very great length (fig. 1, 11, 12); in some cases there is a distinct vacuole, but the films were fixed by the dry method, and this is not good for the finer cytological details. In the gut most of the forms resemble those in the proboscis, but aflagellate forms also occur (fig. 1, 3) and others in which a flagellum is just beginning to grow (fig. 1, 4). At the same time ordinary binary division would appear to take place (fig. 1, 1).

It would be impossible for those familiar with the flagellate parasites of tsetse to confuse this with the pathogenic trypanosomes or *T. grayi* in the gut of the fly, but by our method of routine in which immature infections of the proboscis are examined only in the fresh state it might be missed in that site. Before this instance, therefore, it did not occur in the guts of 3,600 *G. morsitans* and 10,000 *G. tachinoides* examined by us, in which all infections encountered were stained and identified. In this locality it must be regarded as having been exceedingly rare and is probably of no economic importance. Bearing in mind, however, the resemblance of herpetomonads to the cultured forms of *Leishmania*, the occurrence of this one in an insect which, so far as we know, takes no other food but blood, and its ability to establish itself so far forward in this insect that it can readily be transferred to any animal on which the fly feeds, render it an organism of some interest to the student of parasitology.

The slides have been sent to Dr. C. M. Wenyon at the Wellcome Bureau of Scientific Research.

Reference.

(1) Lloyd, Ll., & Johnson, W. B. The Trypanosome Infections of Tsetse-Flies in Northern Nigeria and a New Method of Estimation.—Bull. Ent. Res., xiv, Pt. 3, 1924.

REPORT ON AN INVESTIGATION INTO THE EPIDEMIOLOGY OF SLEEPING SICKNESS IN CENTRAL KAVIRONDO, KENYA COLONY.

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(Plate VI and Map.)

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I. Introductory.

The investigations here reported upon were the result of a suggestion put forward by Mr. W. F. Fiske, formerly Medical Entomologist in Uganda and afterwards officer-in-charge of the reclamation of the closed shores of Lake Victoria.

Mr. Fiske had paid much attention to the epidemiology of sleeping sickness on the shores of the lake, especially to the history of the great outbreak as gathered from official minutes, and suggested that investigation of present conditions on the east coast of the lake in the Central Kavirondo country would throw light on the etiology of the disease and help the reclamation of the abandoned territory in Uganda.

The policy adopted by Kenya (then British East Africa) during the epidemic which raged round the lake at the end of the last century and the commencement of this was radically different from that of Uganda. The people of Kavirondo were not forcibly removed from the lake shore, whereas in Uganda wholesale depopulation of all islands and of the mainland within two miles of the water was enforced.

The result that would be expected in Kavirondo would be a natural re-distribution of the population, certain parts being left alone as too dangerous for habitation, and other parts being inhabited, and from time to time perhaps suffering from outbreaks of the disease. The Provincial Commissioner at Kisumu wrote in 1911: "The natives apparently automatically shrink from actual touch with the disease, and retire to a line they consider safe."

Mr. Fiske suggested that it would be found that a number of *Glossina palpalis* represented by a catch of ten males per fly-boy per hour (written for brevity as 10 b.h.) would be the limit of safety if there was a population of over thirty per square mile living in contact with the fly along the coast.

It was to test these theoretical conclusions and to obtain information on other points that the investigations here recorded were undertaken. One hundred miles of coastline were surveyed from this point of view. Other points on which informa-

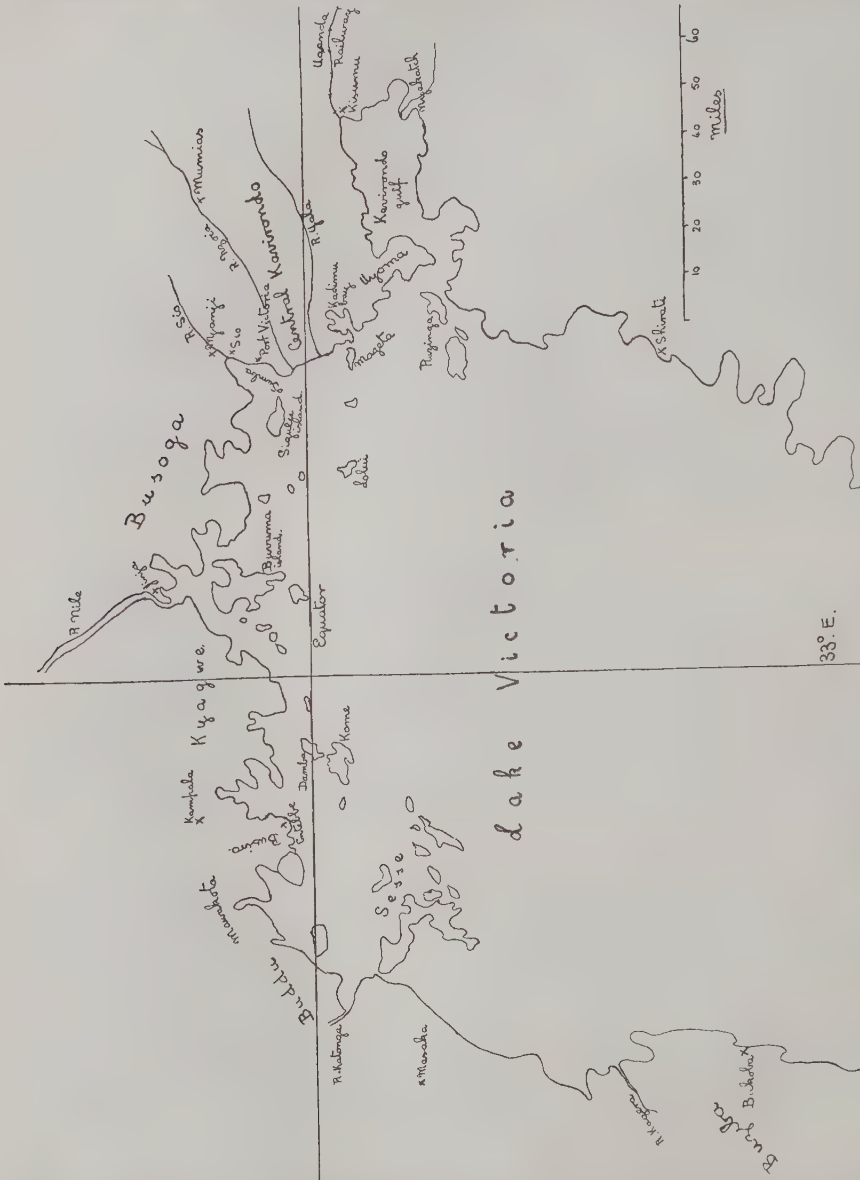


Fig. 1. Sketch-map of the northern coast of Lake Victoria.

tion was sought was the density of infestation by *palpalis* in Kavirondo as compared with Uganda, the rate and direction of spread of the great epidemic, the history of the repeated evacuation and recolonization of Mageta Island, evidence of former

close contact between population and *palpalis*, whether a recent revival of sleeping sicknesss in 1921–22 was indirectly caused by movements resulting from the severe famine of 1918–19, and the possibility that some other insect besides *Glossina palpalis* may be responsible for spreading the disease.

During the whole investigation I was accompanied by Mr. J. M. Campbell, of the Kenya Medical Service, whom the Principal Medical Officer kindly seconded from his routine duties for this purpose.

II. General Description of the Coast examined.

Our method was to examine the coast (fig. 1) on foot when the nature of the country was such that from the steamer, which was used as a mobile camp, no idea could be obtained of the country behind the shore. This was particularly the case from Sio to the south side of Kadimu Bay with the exception of the area where the Nzoia and Yala Rivers flow into the lake through swamps bounded only by a sand-bank. South of Kadimu Bay we found it practicable to coast along in a rowing boat and to land at intervals of about a mile to estimate the number of *palpalis* and examine the country behind the lake-shore fringe of bush. Wherever signs of usage of the lake shore were found, such as a path leading to a watering place, they were followed up.

No account was taken of the population living more than one and a half or two miles from the water, as it was considered that contact with *palpalis* could not be very broad in such cases. But wherever houses were found within that distance of the water an estimate was made of the population, using as a unit a frontage of a mile on the lake shore. No systematic examination of the whole population was attempted, and indeed it would not have been possible, as at many villages the women and children ran away at our approach.

It was deemed inexpedient to puncture glands for the purposes of diagnosis, for reasons which need not be given here.

Having established the fact that trypanosomiasis does exist at the present time, by puncture of the first gland that seemed to be probably due to trypanosomiasis, I made subsequent diagnoses by the nature of the enlarged glands in the neck and axillae, a matter in which I have acquired considerable experience.

For the most part the shore from Sio to the mouth of the Nzoia is fringed with dense bush, and there is no open foreshore ; behind this is a dense jungle of thorny bushes, creepers, and candelabra euphorbia, making thickets of the worst possible type to penetrate. Progress through these was laborious and painful, and often seemed as if it would be impossible until it had been accomplished. On one day it took from 7.30 a.m. to 4.30 p.m. to examine five miles of coast.

Here and there were comparatively open areas thinly inhabited. Near the mouth of the Nzoia River, about two miles to the north of it, there is an open sandy beach on the south side of a hilly promontory known as Namanyu, where a large population clusters at the foot of the hill. This open beach is much used as a rendezvous for fishermen, who draw up their canoes there, but there are other landing places as well all along this coast, the fishing industry being very large. Southwards we came to a dense belt of papyrus, through which the Nzoia enters the lake, and which is, in turn, succeeded by more sand, which appears to hold back the swamps of the Yala River ; this sandy ridge is cultivated, and there is a dense population here along the shore as far as mile 24 from Sio. For a few more miles in the neighbourhood of hills known as Usangi the shore is uninhabited, and then comes a densely populated area under chief Okello at about mile 34 ; the shore here is marshy and rather more open. Uzuri peninsula, with densely bushed shores, is practically uninhabited.

The coast of Kadimu Bay varies ; there are some broad belts of papyrus and some of the densest and most formidable bush, but no open shore. As one goes southwards through Sakwa to Uyoma the country supports more trees (in distinction from bush), and there is often, behind the coastal fringe, good open grass country with acacia trees. There is very little papyrus indeed south of Kadimu Bay to the entrance into Kavirondo Gulf, although great masses of it, torn from its footing in the gulf, are sometimes stranded on the shore (Plate vi, fig. 1) ; these masses seem unable to establish themselves here. Broadly speaking, the coast is remarkably different from the fly-belts so common on the Uganda shores. Instead of forest there is dense thorn scrub, and at only one place, mile 54 (Plate vi, fig. 1), was there the typical fly-beach where big trees overhang an open sandy shore.

This remarkable difference begins almost at the geographical boundary between Kenya and Uganda and is evidently connected with the rainfall along the two coasts. At Mjanji one is between the two types of country, to the west the typical Uganda forests (here lying behind dense belts of papyrus), to the east the dreadful country of thorny bush and creeper, with the barren hills behind Sio. On this tour the inhabitants all said they feared a famine was coming, as the rain had been so inadequate this year.

III. *Glossina* on the Coast of Central Kavirondo.

Glossina palpalis was caught in Kavirondo in numbers up to 82 males per boy per hour (82 b.h.), but this was only at two places, and the average was much lower.

Estimates of the number were made at 71 localities along the 101 miles of coast. There were several long reaches of shore where there was no appropriate shelter for them (*e.g.*, Namanyu Hill and the south end of the sand-banks in front of the Yala swamps), and the number varied from 82 b.h. to 2 b.h. The average was 23 for localities where any *palpalis* occurred.

The distribution of the numbers shows that in 57 of the 71 localities the number was below 40 b.h. and in 31 localities below 20 b.h. On the whole this is comparable with the degree of infestation in Uganda, though a higher maximum (120 b.h.) has been obtained in Uganda.

It is quite certain that along the Kavirondo coast *palpalis* does not occur behind dense banks of papyrus. This, as will be seen later, has an important bearing on the distribution of population along the coast and the presence of sleeping sickness.

As regards the food of *palpalis*, on this coast I found, as I have found elsewhere, ample evidence that this species cares little for the blood of hippos when it can feed upon crocodiles and *Varanus*, the great water-frequenting lizard falsely called *iguana* in this country. In all, 238 *palpalis* were examined microscopically, and for the purposes of estimating the food supply those flies were chosen from the catch which seemed to have fed recently. Of these, 26 contained non-mammalian blood and 10 mammalian blood. The possible sources for the latter are hippos, man, and cattle, the latter only at certain watering places. No tracks of any game were seen, except those of wild pig, whose tunnels through the dense bush showed that they had frequented the country, although none was ever seen. But hippos abounded, and their sleeping places were always near the water in fly-infested bush.

In my fourth report on the bionomics of *G. palpalis*, dated September 1915, and published in the Reports of the Sleeping Sickness Commission of the Royal Society,* I gave the following figures from islands in Lake Victoria. On five islands of small size not inhabited or visited by sitatunga antelope mammalian blood was found in 4 per cent. only of those flies in which blood was recognisable, 96 per

* Repts. S.S. Comm. Royal Soc. xvii, 1919.

cent. having non-mammalian blood. On two larger islands, however, mammalian blood was present in 25 per cent., which indicates the preference of *palpalis* for sitatunga over hippo. For on all these islands hippo blood was readily accessible to the fly, yet in only 4 per cent. of cases had it served as a source of food.

The flies were also examined for trypanosomes. In 11 out of 238 there were flagellates in the gut only, probably the reptilian *T. grayi*; no fly had flagellates in the proboscis or salivary glands, so that it cannot be said that mammalian trypanosomes were seen.

The percentage of female *palpalis* along this coast was low, indicating that the flies have little difficulty in getting food from their favourite *Varanus* lizard; crocodiles were very few along this coast. Probably this is a result of the numbers of *Varanus*, which destroy their eggs and should therefore be rigidly protected. It is noteworthy that the Jaluo inhabitants of this coast do not hunt *Varanus* for its skin, as do the Baganda, yet it is possible that these shy animals were less numerous in the days when the coast was thickly inhabited and many fishermen plied their trade along the shore. In that case the percentage of females would probably have been found higher in those days, indicating greater hunger and therefore greater readiness to attack man.

The average percentage for all localities where *palpalis* was present in numbers above 15 b.h. was 23 per cent.; in one locality it reached 50 and in another 67. This last was remarkably interesting. At the southern entrance to a long bay opening out of Kadimu Bay (see Map, mile 61) a rocky point, densely wooded, projects out between belts of papyrus to east and west of it, forming as it were a rallying ground for *palpalis.* Opposite the rocky point a cluster of rocks with shady bushes lies about 20 yards away and is much frequented by cormorants and other birds, and probably *Varanus.* Examination of *palpalis* caught on this point, where females predominated to the extent of 67 per cent., showed that out of the ten females and five males that were caught here, five females and one male contained non-mammalian blood, which appeared to be avian.

It is highly probable that the unusual proportion of females on this rocky point was due to their congregating there to obtain food from the birds on this islet, only separated from the mainland by twenty yards of water.

Glossina brevipalpis.—In Kadimu Bay and as far south as mile 77 this large species was found haunting the places where hippos sleep in the dense bush, or awaiting their passage along the low tunnels which their frequent journeys keep open, and which were gladly used by us as an easy means of getting down to the water. Directly one entered such a tunnel one heard a loud buzzing of a quality quite different from that of any other fly met on this tour, and it was soon found that this species could be detected by ear alone.

This *Glossina* can be captured very easily, as it sits, head downwards, on the trunks of trees in the open spaces under which the hippos sleep. In thirty-five minutes one fly-boy thus caught 9 males and 4 females. *G. brevipalpis*, in common with *fusca*, which I have found in similar situations on the western border of Uganda, has the habit of buzzing shrilly in an ascending scale with the wings closed (like a Syrphid fly); they may often be seen sitting on a twig or the handle of one's butterfly net singing in this manner. I believe it to be a social call, announcing to their fellows the presence of a good food supply. *G. palpalis* only does this very occasionally, and in this case it seems to be more of a mating call, for with this species one only hears the shrill buzz when the fly is actually sitting on one's person.

G. brevipalpis appears to be decidedly different from *palpalis* in [its preference for mammalian blood. Twelve were examined microscopically, and seven contained mammalian blood, none having fed on birds or reptiles. This is probably of great significance in areas where *brevipalpis* comes into contact with cattle. Along this coast it was taken in abundance at a place much used for watering cattle.

IV. History of the Great Epidemic in Central Kavirondo.

I was unable to find at Kisumu any papers bearing on the history of sleeping sickness earlier than 1909. The following information was obtained from natives, who were questioned systematically at the localities visited all the way down the coast. The most detailed information secured was from the inhabitants of a certain "boma" (group of houses within a common enclosure), who said they had been there for twenty-three years, which was three years before the big epidemic began, placing it back to 1904.

Another informant said that "about 20 years ago" there was great mortality among fish in the lake, which floated on the top and were picked up and eaten. This was actually cited as a cause for the epidemic which began "about two years later." This same account of mortality among fish on the lake was given by two other informants, one of whom also said that large numbers of hippos had also died.

The account of mortality among hippos was likewise obtained on the Yala River by a Medical Officer, when touring in Central Kavirondo in 1910, and the natives said that eating them was the cause of the epidemic. This officer gave the date of onset as "probably seven years ago," placing it at 1903.

It seems probable, therefore, that the epidemic began in 1903–4 along this coast. The report of previous mortality among hippos is interesting on account of the indirect possibility that this may have caused *palpalis* to turn to man with increased eagerness for food. Analogous circumstances are considered by Dr. H. Lyndhurst Duke to have been largely the cause of a recent outbreak of acute trypanosomiasis near Mwanza. But as was shown above, *palpalis* does not feed with sufficient avidity on hippos for their removal to have such an effect. The mortality occurred at about the same time as an outbreak of rinderpest, which may have been a cause. Questioned about this, the natives, who know rinderpest well, said that hippos do die from this disease.

As regards the mortality among fish, it seems possible that this was due to subaqueous emission of volcanic gases. At many places information was obtained that at some time preceeding the great epidemic there had been a very bad famine, so bad that "we had to eat skins." This was followed by, or was coincident with, great mortality from what appears to have been acute dysentery; this outbreak has now become a tradition under the name of "ndonga."

I thought at first that here might have been the chief cause of the increased virulence of the trypanosome which caused the great epidemic, but more detailed enquiry from older men showed that the "ndonga" epidemic was so long ago that "sleeping sickness was as yesterday compared with it." It was before the Government came into the country, which first happened in 1891.

Another interesting event that was told us was the introduction of the jigger flea (*Tunga penetrans*) into this country, which caused a real epidemic of this pest. This occurred before the outbreak of sleeping sickness, but I could not obtain data to fix the year. Mr. Fiske kindly gave me from memory the dates of the onset and onrush of the great epidemic through the country, on the north and west of Lake Victoria, arrived at by study of contemporary documents. Commencing in Busoga in 1901, it reached Buvuma island in 1902, Kyagwe in 1903, the islands of Kome and Damba and the saza of Busiro on the mainland in 1904, Sese islands in 1905, Mawakota and Buddu in 1906, and Buziba (the country around Bukoba in Tanganyika Territory) in 1907.

So that if the epidemic reached Kadimu and Uyoma in 1903–4, it had spread eastwards at approximately the same rate at which it had spread westwards. One informant of more than usually retentive memory told me that the disease began in Busoga at a place called Mukori, whence it spread successively to the islands of Buvuma, Sigulu, Lolui and Mageta, and then to the mainland of Kadimu, Usakwa and Uyoma.

This history of the transmission of the epidemic from island to island, and that there was none on the mainland before it was introduced from Mageta Island, was borne out everywhere I went. That the disease did not spread along the mainland coast around the north-eastern corner of the lake was maintained by the people of Samia, who stoutly affirmed that the epidemic had not affected them and that the cases of sleeping sickness (even recently) that had been known there were immigrants from the Uganda side of the Sio River or had gone there from Sio and returned infected.

This is also borne out by an old map in the office of the Provincial Commissioner at Kisumu, unfortunately not dated, but giving the distribution of sleeping sickness in the time of the epidemic. It shows that cases of sleeping sickness were not found further north than the point where the range of hills behind Sio abuts on the lake at its southern end.

The inhabitants of Sigulu Island left there for Lolui Isle, and these people, together with the Ba-sigulu immigrants, also moved about 19 years ago and went to Mageta Isle, where they apparently introduced the disease, and thus it spread to the adjacent coast of Kadimu on the mainland. Several informants said that it took about two years to develop into an epidemic on Mageta, and then began the exodus to the Kadimu coast.

Down in Uyoma we met an intelligent native from the large island Ruzinga, at the entrance to the Kavirondo Gulf, on the south side, who said that the epidemic took two years to get there from the mainland and lasted until six years ago, when it ceased. This would place the date of introduction to Ruzinga as 1907; this date was also given by Dr. Rendle, who made some enquiries into the question during the war.

It seems extremely probable that the epidemic was carried directly from Southern Uyoma to Ruzinga Island by canoe traffic, which is frequent between the two places, just as it reached Kadimu through Mageta, and that it may not have travelled continuously all round the coast of the Kavirondo Gulf.

The epidemic appears to have died down suddenly, probably because most of the people had died or left the lake shore. Several times the natives, when questioned, gave the answer that "it stopped everywhere at once."

In October 1911 the Provincial Commissioner reported that the mortality was now slight, and that the natives were showing a tendency to return to the lake shore. At this time, then, it had ceased to trouble the natives, but occasional cases were reported by officials in 1915 from Kibigori, east of Kisumu, in 1917 from near the Yala swamp, and from Southern Kavirondo. By 1920 the disease had flared up again, and was causing trouble on the south coast of the head of Kavirondo Gulf near Kisumu, and in 1921 Mageta Island was badly infected, and there was much sickness on the mainland coast of Kadimu opposite the island. The people of Mageta finally evacuated the island as a residence two or three years ago, and the disease now appears to be quiescent in Kadimu. But it is interesting to note that in some parts of Kadimu there is still a considerable dread of the disease. Thus at mile 68 we were told of a case in a boma some two miles inland. We enquired on the way from a fine old native, who said contemptuously that "every illness was supposed to be sleeping sickness" and that the case in question was one of "swollen arm." This it proved to be, a woman dying of septic poisoning from the arm, with gangrenous toes.

V. Sigulu and Mageta Islands.

The history of Sigulu, and especially of Mageta Island, is of great value for the epidemiological study of sleeping sickness. Sigulu Island, lying close to the mainland of Uganda, has thick forest over a great part of it, especially along the lake shore,

where on the north side of the island are wide belts of papyrus. On this island *palpalis* occurs abundantly behind the papyrus, where it finds adequate shelter in the forest.

According to my informants sleeping sickness came to Sigulu from Buvuma Island, and Sigulu was soon evacuated, at some time before 1913, but I have no exact data. In 1910 a number of them returned, reported as six bomas, but were removed by the Government of Uganda a few years later. It is persistently stated that none of them had sleeping sickness, nor did they develop it after leaving the island. This has a bearing on the questions discussed at length in Section II, viz., the density of population necessary to result in infection. In 1915, a few people from Mumias, in Kavirondo, were found to have returned to the island and were removed.

Near to the eastern end of Sigulu is a little island named Sumba, which we visited, and estimates of the degree of infestation by *palpalis* were made at several places. This little island is composed of a rocky conical grass-clad hill sloping down to the strip of bush which fringes the water, and runs up the hill a little way, where there is soil enough. A great amount of labour had been spent by former inhabitants in making terraces up the slopes, which reminded one of vineyards.

Along the shore in front of these terraces *palpalis* existed at the rate of 64 b.h.; at two other localities at the rate of 30 b.h. and 16 b.h. The average for the island thus works out at 37 b.h., which has been enough to cause the epidemic. As a matter of fact, the number would possibly have been smaller in the days when the island was cultivated.

An intelligent old man who was born on Sigulu said that when he was a boy he went to Sumba for two years, but at the end of that time returned to Sigulu, "as all the people on Sumba had died." The disease began on Sigulu and was brought to Sumba from there.

In the case of Mageta Island a more detailed history has been made out. About 19–20 years ago, when the people left Lolui Island some went to Mageta, and this was the commencement of the epidemic which resulted in the evacuation of the island. But as the people saw the inhabitants of the mainland dying of the same disease, there seemed to them to be no reason why they should stay away from the island, and some of them returned, to be removed in 1910. By 1911, however, some had returned again, and in March 1914 a Medical Officer reported that there were "42 families" there, half of which had come in 1911 and the rest in 1913. No cases of sleeping sickness were reported by the Medical Officers who visited the island in March and June 1914.

As was the case on Sigulu, it appears that this number of people on the island was not enough to give rise to sleeping sickness. However, about 1918, there was a large immigration into the island, and the infection lighted up. In 1919, 104 huts were reported, giving a population of about 125 adults or 42 per square mile of the inhabited part of the island. A Medical Officer (Dr. Beven) reported in 1921 that there were about 90 natives on the island (about 25 per square mile), of whom 35 showed signs of trypanosomiasis, and a number of deaths were reported for the previous year. Finally the natives of their own free will evacuated the island two years ago (1922), and most of them settled down in Kadimu, where we found them. It is noteworthy that on the occasion of this exodus, although the islanders were highly infective, for some of them died since their arrival on the mainland, the density of population along the shore was apparently not large enough to cause the infection to spread; this point is dealt with more particularly later (p. 200).

On examining Mageta Isle we found the old cultivations, now swamped by jungle growth of thorn, on the north shore at the east and west ends of the island, and on the south shore at the west end. There is a small amount of comparatively open ground on the crest of the ridge, but now so overwhelmed by the sea of thorn that

it was difficult to tell how much open ground there had been before. All around the coast is a fringe of dark, shade-producing trees and dense thorny jungle, but here and there remnants of banana plantations still throw up shoots.

Flies were caught at 15 different points around the coast of the island, and the following figures (per boy hour of male flies) were obtained: 31·5, 26, 43·5, 61·5, 20, 40, 19·5, 52, 40, 39, 46·5, 31·5, 45, 24, 30, giving an average of 30 b.h. for the whole island. We thus arrive at the definite conclusion that broad contact between population of the density of 42 per square mile with *palpalis* at the rate of 30 b.h. results in an epidemic of sleeping sickness.

VI. Evidence of former close Contact between Tsetses and Population.

It was very obvious from our survey that contact must have been very broad indeed between the former population and *Glossina* along the greater part of this coast at the time of the epidemic.

The present inhabitants often pointed out long stretches of country formerly so thickly inhabited that "there used to be no trees, only houses" on land which is now densely covered with the appalling thorn jungle through which we had to make our way. We ourselves were able to see the remains of old bomas within a few hundred yards of the water, and found an old grindstone embedded in its original site, showing that there had been a house within two hundred or one hundred and fifty yards of the water. Moreover, all along the coast at intervals can be seen old fish-traps of reed, which is now growing, but showing by its arrangement how it was originally put there. Some of the older men when questioned about the epidemic gave a graphic description of the destruction of the dense lake shore population.

An interesting find was made at mile 80. Along the shore was a comparatively narrow belt of the usual dense bush; behind was open country with scattered acacia trees. Immediately behind the belt of bush, and indeed partly among it (though this is probably due to recent overgrowth of the bush), was a wall built up of blocks of stone enclosing a space about forty yards in diameter and not more than that distance from the water.

My interpreter, a Jaluo native of these parts, said that no inhabitants of the country at the present day made these stone-walled bomas, and that it was a relic of the days several generations ago when the Masai people inhabited this country, and before the people of Nilotic origin, the present Jaluo, came down from the North.

This explanation, however, may be incorrect, and it may be that this stone wall was built as a defence against Masai attacks. But the point is that one cannot conceive how a settlement like this could have escaped sleeping sickness had the *palpalis* in those days been infected. Either the supposition is correct that *T. gambiense* was introduced for the first time at the end of the nineteenth century, or there should be some history obtainable from the Masai, if indeed they did inhabit this country in bygone days, of epidemics among the dwellers by the lake.

VII. The Famine of 1918–19 as a Cause of an Outbreak of increased Virulence.

One of the points suggested by Mr. Fiske for enquiry was whether the outbreak of sleeping sickness that occurred along the Kavirondo coast in 1921–22 may have been due to a return of many people to the lake shore on account of the severe famine after the war. The number of people in contact with *palpalis* may have been sufficiently raised to heighten the virulence of the trypanosome through mechanical transmission at watering places, etc. I found no evidence of any such large influx,

and much to the contrary. Indeed, at a meeting of the Kadimu chiefs, the opinion was expressed that the outbreak of sleeping sickness just after the war had actually begun before the famine was felt.

The country along the lake shore is obviously dry, and at the time of our visit the inhabitants all said the rains had been inadequate and they feared a famine. It was obvious that the crops within a mile or two of the lake were drying up for want of rain, in spite of the fact that the rainfall records for Uganda in April showed for 19 stations an excess over normal averaging 3·4 inches. Only 5 of the 25 recording stations showed a deficit averaging 1·2 inches, and these are far to the north or west of the Kavirondo country. One station recorded no difference from normal. The two recording stations nearest the Kavirondo coast showed an excess of 1·36 (Mbale) and 4·64 (Mt. Elgon). The Senior Commissioner, Kisumu, kindly informs me that the rainfall at Kisumu last April was 7·92, the average for the last eleven years being 7·67. Kisumu, however, lies much closer to the high Nandi escarpment, which draws most of the rain ; the coast of Central Kavirondo is well to the west of this and, unlike Southern Kavirondo, has no high hills to draw the rain.

Over and over again I got the answer "There was no food here and we had to go inland to get it ; no one came here to buy food." Occasionally one found that the local inhabitants had cultivated a bit nearer the water where they could get potatoes to grow in the damper soil. At Sio and at the mouths of the Nzoia and Yala Rivers it was interesting to note that people left these localities for Uganda, and many have not come back. Some, however, did return and were made to keep to themselves by the local residents, who recognised that some were infected ; the disease did not spread in either locality. About 1½ miles south of Sio the local headman said that in 1917 he enlisted, and when he came back in 1923 he found many people had gone.

At the settlement of Chief Okello at mile 34 where there is a dense population at present living safely I was told that people had come there to buy food during the famine, but this is not likely to have caused an increase of sleeping sickness in the absence of contact with fly. At one locality, Wayendhe (about mile 60), some people have actually emigrated recently as they fear another famine. At Maresa (about mile 62) the people sold fish and so obtained other food ; but it may be said here in advance that there is not sufficient contact with fly here to spread sleeping sickness. But in the case of one boma at Maresa the history of one case of the disease definitely suggested that movements caused by famine resulted in infection. The people in this boma used to live near Serawongo Hill, but about 3½ years ago moved to Siungu (or Chaussu) point on account of the famine in 1919. In August, 1923, they left this locality on account of "myriads of mosquitos and tsetse-flies." A young woman in this boma had enlarged cervical and axillary glands, most typical of sleeping sickness. It may be said that ample evidence was obtained that Siungu point had once been thickly populated.

VIII. Present State of the Disease in Central Kavirondo.

The temporary exacerbation of the disease in both Central and Southern Kavirondo did not last long. It was enough to frighten the natives thoroughly, and perhaps produced its own remedy (*e.g.*, the evacuation of Mageta Island). At any rate, one could get no information anywhere of sleeping sickness at the present time, nor of any recent deaths save in the colony of emigrants from Mageta, which is dealt with later (p. 200). Cases that were discovered on the present tour at miles 27 in Kadimu, 93½, 98 and 101 in Uyoma, were not known to the natives themselves and were discovered fortuitously by examination of such natives as were available. Several of them had glands apparently sclerosed, which is held in Uganda to indicate that the trypanosome has been conquered by the individual's natural resistance.

Inquiry into cases reported in Kadimu by Dr. Beven in 1921–22 showed that the only four who could be traced had died, so that the exacerbation of the disease at that time had heightened the virulence of the trypanosome. Now, however, the absence of mortality is encouraging the natives to return closer to the shore. Unless this process is carefully watched and the natives are shepherded into comparatively fly-free localities, and made to clear their watering places adequately (a minimum of 400 yards frontage), there is bound to be another period of heightening of the virulence of the trypanosome and subsequent mortality. The following section shows that every effort should be made to take advantage of the natural protection afforded by dense belts of papyrus.

IX. Protective Value of Papyrus Belts.

The first locality where the population was taking advantage of the safety afforded by papyrus belts was at mile 33–34, at the western end of the strip of shore inhabited by a large population under chief Okello. A belt of papyrus commences on the north coast of Usangi Bay and becomes gradually thicker towards the head of the bay, where it fills up the northern angle. All round the head of the bay and behind the papyrus are houses and cultivation, and I found no *palpalis* there. Just beyond the end of the papyrus belt, however, where a belt of the usual lake shore bushes gives adequate shelter, *palpalis* was present at the rate of 22 b.h. (mile 33½) and at 12 b.h. (mile 33).

The last house, westwards, of the settlement was just behind the western end of the commencement of the papyrus belt, and the position could hardly have been more neatly chosen to obtain safety and yet extend the settlement as far as possible. The people of these further bomas send their goats out westwards to graze, but no longer cultivate beyond the end of the papyrus. I found ample evidence there that behind the locality where fly occurred at the rate of 22 b.h. there had been bomas not long ago, and it is especially interesting that three of Dr. Beven's cases, now deceased, are reported to have lived out in this direction beyond the papyrus.

At mile 41, on Uzuri peninsula, another extremely apt example was found. The only two houses on the peninsula are situated at the head of an inlet where papyrus replaces the usual lake shore bush. The man found living there said that in his father's day there used to be many more people living close to the water, but they all died except just where he was. No *palpalis* were found here, but elsewhere round the coast of the peninsula fly was found at different localities as follows :—64, 16, 28, 28·5, 38 per boy per hour.

At mile 44½, at the eastern side of the base of the peninsula, the same kind of thing was noted. A man had recently established his boma behind a dense belt of papyrus, but near its end. He had lived there formerly in the great epidemic, but beyond the edge of the papyrus many people had lived and had died from sleeping sickness.

Between miles 44 and 47 is a northern sub-division of Kadimu Bay with two large semi-circular masses of papyrus covering altogether about two miles frontage, and each at its greatest breadth extending back for about half a mile from the water. There was a dense population behind each of the belts of papyrus, with large areas of cultivation. Between the two belts is a piece of coast where the papyrus is reduced to a minimum, or barely exists, and there is a little bush along the shore. I expected to find fly here, but did not. It was remarkable that there was no cultivation behind the papyrus-free belt ; it may be that the papyrus is an indication of some condition making the soil more suitable for cultivation. A search for *palpalis* behind the western of the two papyrus masses revealed one male fly in ten minutes, which was probably a wanderer from the bush to the south ; just beyond the border of the eastern mass of papyrus fly was found at the rate of 6 b.h.

Beyond this the shore was heavily infested with fly, with catches at the rate of 32, 82 and 32, at three successive localities about a mile apart. The high ground behind this had obviously been cultivated in former days, but is now densely covered with secondary growth of bush. A man now living in a boma long established behind the shelter of the eastern of the two masses of papyrus above mentioned said that people from these localities had had sleeping sickness very badly, and had emigrated to his neighbourhood, where they had died. But apparently the inhabitants of the boma itself, which goes back for several generations, had had no need to evacuate it, being safe behind the papyrus where there are no *palpalis*.

Another good example is furnished by the locality known as Wayendhe, at the head of the southern arm of Kadimu Bay, where there is a dense population, estimated at between 250–300 per square mile. The whole of this long narrow bay is lined with a broad belt of papyrus, especially thick at the head and on the south coast. At a point about half way along the south coast one female *palpalis* was taken by two expert fly boys in a quarter of an hour ; it had doubtless wandered along from the rocky point at the entrance to the bay, which has already been alluded to (p. 191). Several of the inhabitants were questioned who were old enough to remember the great epidemic along the coast, but they insisted that it had not been felt at Wayendhe. There can be little doubt that the absence of sleeping sickness here coincided with absence of *palpalis*, but also that there must have been cases from the surrounding country (round Serawongo, for example, where the disease is known to have been acute) who would at least have come into Wayendhe before they were really ill. Yet the infection did not spread, and this point leads to the next section.

X. Are there other Agents besides *Glossina* responsible for transmitting Sleeping Sickness on a Large Scale?

In order to obtain data bearing on this point, we made a special journey to a locality named Ndiwo, on the Yala River, where there had been sleeping sickness in former days, and where *palpalis* was said to be absent. The Yala River for some ten miles above its actual entrance into the lake flows through large areas of swamp, and its actual point of entry was not seen. Along that part of the coast is a great ridge of sand, densely inhabited, which acts as a barrier between the swamps and the lake. Numerous channels were cut through this bank, six generations ago, by the natives, to drain the Yala swamps. This object appears to have been largely achieved, as will be seen below. The Yala flows at the northern foot of some rather higher ground on which lies the settlement of Ndiwo ; to the north of the river, and of Ndiwo, is a piece of open water named Gangu or Kanyaboli, and south of the river and west of Ndiwo is a smaller lake called Nyamboyu.

To reach Ndiwo, we went from Okello's headquarters at mile 34, past Lake Saru, an inlet from Lake Victoria, some $2\frac{1}{2}$ miles long by $1\frac{1}{2}$ broad, and entirely surrounded by a dense belt of papyrus. Behind the papyrus is little or no shelter for *palpalis*, there being only a few scattered trees, and no fly could be found.

A large population lives on the high ground all around this lake, and in the papyrus are some of the Bakenyi people, who always make this their home. Dr. Beven reported in 1921–22 that he had found three cases suggestive of early trypanosomiasis in the Bakenyi colony, but the diagnosis was not confirmed or contradicted microscopically. The map of distribution of the epidemic already mentioned shows no cases actually around Lake Saru, although it was indicated along the coast in front of it.

The headman at Lake Saru said he had never heard of sleeping sickness among the Jaluo people living all round Saru, neither did he know anything about the three possible cases reported by Dr. Beven. It may therefore be considered as at least

doubtful if this locality offers any evidence of the transmission of sleeping sickness by any agents other than *Glossina*. Usangi point, quite near the opening into Lake Saru, abounds with *Glossina*, and there is ample evidence that its inhabitants in former days evacuated that area on account of the disease.

Having passed Lake Saru, we travelled past the south-eastern corner of Lake Nyamboyu. There were a few bomas at some distance to the east of the water, but there was ample evidence that there had formerly been many people living there, as the country was overgrown with the dense bush that covers land once cultivated and neglected. The local headman said that many people had formerly died from sleeping sickness in this locality.

Camp was pitched on the high ground of Ndiwo and the country examined. At first sight it seemed certain that the epidemic in this area must have been due to something else than *Glossina*. Lake Nyamboyu is a shallow basin surrounded by a dense belt of rushes and a little unhappy-looking papyrus and with no good shelter of the kind required by *palpalis* near the water. But along the south side of the basin, at a distance of about one hundred yards from the water, is a belt of forest with big trees, having a perfectly definite frontage abutting on the open grass land, that now intervenes between it and the back of the belt of rushes around the water. It is particularly noteworthy that the big trees in this belt are dead and barkless, and have obviously been dead for some years. Beneath them the usual xerophilous bush, so dense along the coast of this country, is rapidly establishing itself.

Examination of the flat open grass land north of Lake Nyamboyu, between it and the river, showed many clumps of date palms dotted about, looking very dried up and miserable, and evidently not at all flourishing (Plate vi, fig. 2). Also dotted about were small tussocks strikingly suggestive of former growth of papyrus. This seemed to me to be the key to the situation. Enquiry revealed that at the time of the great epidemic 20 years ago all this ground was marsh. The palm trees would then have flourished exceedingly and their clumps dotted about would have furnished excellent shelter for *palpalis*, as is the case at the present day on the Mpologoma swamp in Uganda. A small rise of level of the swamp would cover all this land now dry, and would bring Lake Nyamboyu up to the edge of the forest belt on its south side, now drying up. Perhaps the most suggestive fact of all was the discovery by a fly boy, after a whole morning's search, of a single *palpalis* in the rushes around Lake Nyamboyu.

The history of the epidemic at Ndiwo therefore seems quite clear, and may be prefaced by an extract from a report in 1906 by the then Principal Medical Officer of Uganda, Dr. A. D. P. Hodges, on the experiences of Dr. C. A. Wiggins, who was engaged from February 1906 in investigating the conditions in the southern part of the Usoga district. "Dr. Wiggins' experiences in southern Usoga were not only quite exceptional as regards the experiences of other observers, but were probably quite unusual in the locality itself. The seasonal conditions at the time were most abnormal, with excessive rains, extensive floods, and an unprecedentedly high lake-level, so that he describes large areas as being covered with water which was only hidden by the grass, and in this flooded country the fly was more or less scattered through the bush over a wide range from the lake. On several occasions, too, he found these island flies more plentiful than at the corresponding lake shore."

This record shows what seasonal variations may do in increasing the range of the fly; and it is highly probable that the level of the swamps of the Yala would have been much higher at that time. Lake Nyamboyu would then have extended up to the level of the forest belt, now far from it, and would have surrounded the clumps of palms with water. The natives said that at the time of the commencement of the late war the area north of Lake Nyamboyu was still under water, but at about the end of the war it began to dry up (1918–19 were very dry years) and papyrus began to cover the area. As desiccation continued this was burnt and natives commenced

to cultivate and live there, so that in the time of the famine food crops were obtained. Apparently even the waters of Nyamboyu dried up, for crops were taken from its bed ; last year (1923), however, the heavy rains had resulted in the return of water there, which we saw from our camp.

In comparison with this it is worth noting that a few cases of sleeping sickness were reported from the Yala swamp in 1917 and that 1916 was an exceptionally wet year, the rainfall as recorded at Kisumu having been almost double the normal in April. It seems highly probable that at the time of high water *palpalis* may have abounded among the palm trees and along the belt of trees which would then have been at the edge of Lake Nyamboyu. Yet nothing seemed more obvious when one first got to Ndiwo than that here was a locality where the epidemic *could* not have been due to *palpalis*.

It is possible that the gradual desiccation of this swamp has been produced by channels which have been cut through the sand banks by the natives between the swamps and Lake Victoria.

Further evidence bearing on the possibility of transmission by agents other than *Glossina* may be cited. There seems never to have been any sleeping sickness epidemic in the country for several miles south of Sio, where *Glossina* is scarce. But the inhabitants themselves have told me that people from here have been to Mjanji, in Uganda, and have returned infected, but that the disease never spread, because, in their opinion, they had made the infected persons keep to themselves. While there are apparently no *Glossina* in the neighbourhood of Sio, in Kenya, and very few in the country for a few miles south of Sio, there are abundant mosquitos and presumably household pests of the usual kind.

But more complete evidence was obtained at a locality named Maresa, at mile 62–63, at the south entrance to Kadimu Bay. At the actual entrance is a rocky point which has been already alluded to (p. 191), and south of that is a belt of papyrus, behind which are several bomas and then a much larger and denser belt separated from the former by a comparatively open piece of marshy shore, about 20 yards long, which is used as a watering and landing place. Running back from this place is a belt of rather neglected and overgrown banana plantation, which roughly divides the coastal area into two.

A thorough survey was made of the conditions here, and eight bomas were found behind the papyrus and one more about a mile farther back up the hill, of which there is more to be said later. The total number of people living here was found to be sixty, not counting children, who could not be estimated, and they occupied an area of not more than one square mile. Thirty-four were originally inhabitants of Lolui, who had been driven out to Mageta and had come here from Mageta three years ago. The other twenty-six people were Jaluo, and some of them had been there before the Lolui people came ; they all insisted that none of them had acquired sleeping sickness. I examined all that I could find, namely, one man, five women and six children, and found one case, the woman previously mentioned in Section VII, whose infection was due to living at Siungu. But out of the thirty-four people who had come from Mageta all the men (15) and twelve of the nineteen women were examined, and also six children. Two young men showed the enlarged, soft, cervical and axillary glands typical of early trypanosomiasis.

One older man had similar glands, and another showed glands which had sclerosed but were very probably the result of trypanosomiasis. One of the young men at least showed clinical evidence of sleeping sickness in tremors of the tongue and wasting. Recently the headman of the settlement had sent away to the adjoining islet of Sifu eight people who had obviously got sleeping sickness (a man, two women, and five girls and children). These had all died, the last one only ten days before, who was the wife of one of the young men who was found to be infected and had been with her on the island until she died.

So that there can be little doubt that during the last three years the Jaluo people living at Maresa have been in closest contact with infective people from Mageta; one Jaluo boma was actually next door to a boma of Lolui people, one of whom was infected. *Yet none of the Jaluo people have become infected.* An estimate was made of the number of *palpalis* present along the coast in front of the bomas. At an open place at the north end of this strip, just beyond the north end of the papyrus, *palpalis* was taken at the rate of 28 b.h. But the inhabitants said that they very rarely went there, as there were other watering places behind the papyrus, and the absence of a used path bore out that statement. In the overgrown and neglected banana plantation *palpalis* was found at the rate of 24 b.h., but here again there could be very little contact between fly and people. Occasionally a visitor might pass from one group of bomas to the other, but the main population was to the south of the plantation. The plantation is not cultivated and looked after, and there would only be occasional contact when a person went in to look for a bunch of bananas; the neglected state of the plantation, which showed how little it was used, is the direct cause of its infestation with fly.

At the open place on the marshy shore where the Lolui people arranged their fishing nets and embarked in their canoes *palpalis* was present, but only at the rate of 4 b.h. At another place behind the papyrus, between it and a boma, *palpalis* was again taken at the rate of 4 b.h.; the papyrus was thin and there was a thin fringe of bush behind it. Finally, at another part of the shore, marshy, just to the south-west of the main belt of papyrus, we found some canoes drawn up. There is a very thin belt of bush which shelters fly at the rate of 12 b.h.; cattle are taken to water there, and it is used as a watering place by the people of the outlying boma of Maresa, the one up a hill a mile away from the lake, in which was found the infected woman.

While there would be slight contact here between a few of the population and *palpalis*, the chief watering place and landing place, where contact would be broad, had fly only at 4 b.h. This amount has apparently been insufficient to cause infection to spread from Lolui to Jaluo people, living even as closely together as they do, but, more significant still, neither has any *other* agent been able to do this, even though the trypanosome exists in the locality in lethal form. It may be said here that while these Lolui people still visit Mageta from time to time, only the men go, the women disliking the journey. This may account for the fact that of the cases found at Maresa all were men except the Jaluo woman, whose infection is explicable by her past history. The Jaluo people do not visit Mageta, as they have no suitable canoes.

Finally, as bearing on this issue, my experience in the Northern Province of Uganda may be cited. Before the Nile leaves Uganda for the Sudan it flows through the Madi country, in which most of the rivers are infested with *palpalis* and sleeping sickness in lethal form is endemic. But that part of Madi which shows fewest cases of sleeping sickness per head of population is the country along the Nile where, owing to the nature of the banks themselves, *Glossina* is not nearly so abundant as along the smaller rivers, and often cannot be found. Yet mosquitos, both Culicine and Anopheline, are here in such abundance that on a recent tour through this country, even in the driest time of the year, one was forced to retire to bed at sunset.

If mosquitos can spread the disease outside laboratory conditions, how is it that although a few cases of trypanosomiasis are present along the banks of the Nile they do not serve as a source from which mosquitos can infect others?

XI. Inter-relation in Central Kavirondo between Population and *Glossina*.

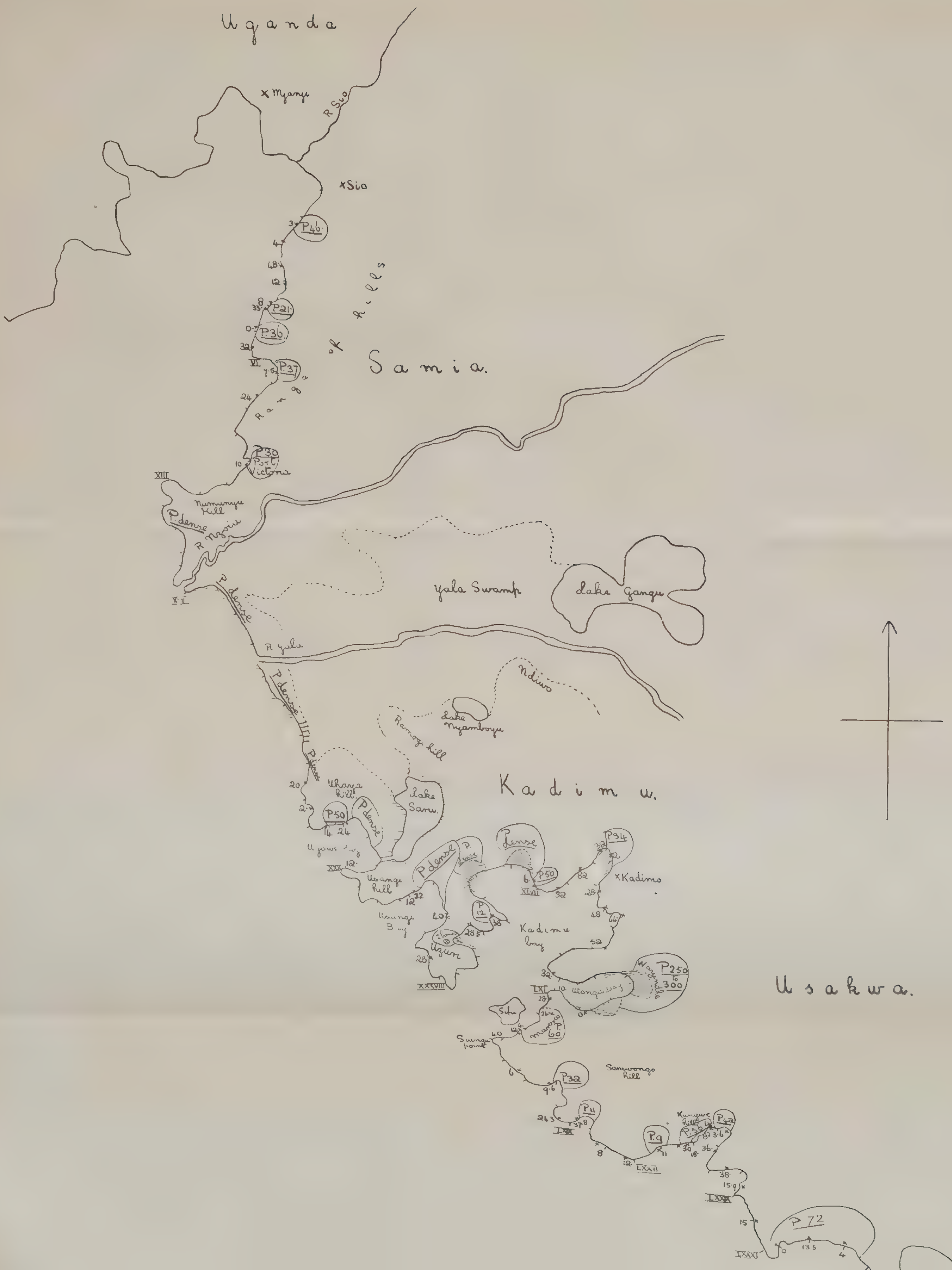
An attempt was made to estimate the breadth of contact between *Glossina* and the population who could be considered to come into contact with it. Those living more than about one or rarely one and a half miles away from the water usually

had watering places other than the lake itself, so that their contact with *palpalis* was considered negligible, as very little, if any, fishing is done by people living more than a mile away from the lake.

Whenever a part of the shore was found to be obviously used by people, the number of bomas behind it (with the above limitation) was investigated, and an estimate made of the adult population per square mile of the lake shore concerned. The result has been indicated on the map thus, P60. At some places the number of bomas was very large and was not counted, " P. dense " is then written on the map, indicating an adult population of, probably, more than 300 per square mile for that small part of the lake-shore.

The following tables give the numbers of *palpalis* taken at the 71 localities along the 101 miles of coast that were examined, and the number per square mile of adults that were considered to be in contact with them. The figures for *palpalis* are also marked on the map against small crosses indicating the points at which they were taken. The population figures are also entered, behind the coast line, and the coastline is ticked off at intervals of a mile, the mileage being indicated here and there in Roman numerals.

Locality.	Mileage.	Number of male *palpalis* per boy per hour.	Population per square mile in contact. with fly.	Locality.	Mileage.	Number of male *palpalis* per boy per hour.	Population per square mile in contact. with fly.
1	1	3	46	37	63½	40	—
2	1½	4	—	38	65½	6	—
3	2	48	—	39	66½	10	33
4	3	12	—	40	68½	24	—
5	4	8	22	41	69½	38	—
5A	4	33	—	41A	69½	11	11
6	4½	0	36	42	70½	8	—
7	5½	32	—	43	72	12	—
8	6½	7	37	44	73	11	9
9	7½	24	—	45	73½	30	—
10	10	10	about 30	45A	74	18	56
11	24½	20	—	46	74½	82	—
12	25½	2	—	47	75	4	42
13	26½	14	—	48	76	36	—
14	*27*	*24*	*50 or more*	49	77½	38	60, very doubtfully in contact.
15	33	12	—				
15A	33¼	22	—				
16	35	40	—	50	78½	16	—
17	37	28	—	51	80	15	—
18	42	28	—	52	82	0	
19	42½	38	about 10	53	83	13	72
20	46½	6	50 or more	54	84	4	
21	48	32	—	55	85½	39	
22	48½	82	—	56	87	9	50 or more, doubtfully in contact.
23	49½	32	—				
24	50	21	34, but contact very slight.				
				57	88	12	
25	51	28	—	58	89	12	—
26	52	48	—	59	90	39	—
27	52½	64	—	60	91½	48	—
28	53½	52	—	*61*	*92½*	*20*	*54*
29	56	32	—	61A	93	12	—
30	60	0	—	62	95	46	—
31	61	10	—	63	96	36	—
32	61½	28		*64*	*97*	*16*	*81*
33	62	24		65	99½	32	—
34	62½	4	Maresa 60	66	100	6	35
35	62½	4					
36	63	12					


Uganda
x Myanye
R Sio
x Sio
Range of hills
Samia.
P46
P21
P36
P37
P30
Port Victoria
Numunyu Hill
P. dense
R Nzoia
P dense
Yala Swamp
Lake Gangu
R Yala
Ndiwo
Lake Nyamboyo
Ramogi hill
Kadimu.
Uhaya hill
Lake Sanu
P50
P dense
Usenge hill
Usenge Bay
Uzuri
P 12
P50
x Kadimo
P34
Kadimu bay
P250 to 300
Usakwa.
Sifu
Sumngu point
P 60
P32
Samwongo Hill
P11
P9
Kungwe Hill
P42
P 72

The several localities at which the population was considered to be in touch with the fly will now be dealt with seriatim.

Locality 1, about a mile to the south of Sio itself.

This was the first place where *palpalis* was encountered south of Sio, at the rate of 3 b.h.; there was not a broad belt of bush by the water. At a small gap in this bush fishermen were arranging nets, and other people were drawing water. Two *palpalis* were seen sitting on the back of one of the fishermen. The number of people in the houses, which were only about half a mile back from this watering place, was estimated at 46 per square mile. There was never any sleeping sickness in this locality, and examination of 35 men and youths, with 11 women from the houses, revealed no cases of enlarged glands. A population of 46 per square mile can therefore live in fairly close contact with *palpalis* at 3 b.h. without danger.

Locality 5, about four miles south of Sio.

Fly was taken in the lake shore belt of bush at the rate of 8 b.h., and there were houses about 100 yards away from this. The population, comprising about 15 of the people who had formerly been evacuated from Sigulu, and therefore might have been a source of trypanosomes in former days, was estimated at 22 per square mile. They said there had never been any sleeping sickness here. They had no canoes, but catch fish in traps along the shore. Therefore close contact between fly at 8 b.h. and population of 21 per square mile has not produced sleeping sickness.

Locality 5a.

Very close to the last locality, a few huts lay in two groups behind the narrow fringe of lake-shore bush; the people drew water from the shore between these two groups. Less than 400 yards beyond these huts was a point covered with dense bush, but apparently not entering into the lives of the people, who were estimated at 9 per square mile for that small area. Five adults were examined and showed no signs of infection, nor was there any sleeping sickness ever known here. Yet *palpalis* was present on the point at the rate of 33 b.h.; thus a small population can live close to that number of *palpalis* in safety, provided that their daily occupation does not bring them into contact with the fly.

Locality 6, mile 4½.

At this locality the two boys took only two *female* flies, which is equivalent to a negative in the system of record adopted. The population was estimated at 36 per square mile; many of them had come from Sigulu Island. It was definitely stated that all who came from Sigulu were alive.

Locality 8, mile 6½.

A flat shore with a narrow fringe of bush and long vegetation containing some banana shambas; behind, open land covered with thin grass. *G. palpalis* were present along the shore at 7·5 b.h. and in the banana shambas at 6 b.h. Population estimated at 37 per square mile. Sleeping sickness had never been known just here, and examination of the people available (21, and 6 children) revealed no cases. Contact between fly at 7·5 b.h. and population at 37 per square mile seems harmless.

Locality 10, mile 10.

Known as Port Victoria, as it was formerly chosen for the terminus of the Uganda Railway. There is a narrow line of thin bush fringing a marshy shore, in which attempts are made to grow potatoes. Cattle are watered at a place where the bushes are slightly thicker, and at this point a catch of fly was obtained of 10 b.h., whereas elsewhere it was at the rate of 2 b.h. The people lived about half a mile back from the water; an exact estimate was not made, but the number was probably about

30 to the square mile. Some had come from Sigulu, and none of these had died. There was no evidence or history of sleeping sickness in this locality at the time of our visit.

Locality 11, mile $24\frac{1}{2}$.

The condition here is somewhat similar to that described at 5a. A wooded point shelters *palpalis* at the rate of 20 b.h., but is only visited by woodcutters and does not enter into the lives of the general population living a mile or more away and getting water from an open fly-free shore.

Locality 14, mile 27.

This furnished the first case of sleeping sickness, which was discovered more or less by accident, as it was impossible to collect the whole population for systematic inspection; at many places the women and children ran away at our approach. On the north shore of Ugowe Bay a catch of fly was made at mile $26\frac{1}{2}$, where there was a belt of bush along the water and an old banana plantation. Voices were heard behind the bush, but there were no houses just there. About half a mile toward the head of the bay there was one boma of seven houses within a quarter of a mile of the water in open ground, and five more bomas another quarter of a mile further back.

The watering place is among the bushes of the lake-shore, where fly was obtained at the rate of 24 b.h. The man found infected (as proved by microscopy) had lived in the village about half a mile back from the water ever since he was born; he had a well-nourished appearance but looked somewhat heavy in the face. This locality shows that contact between a population of 50 per square mile and *palpalis* at 24 b.h. produces sleeping sickness.

Beyond mile 24 is a dense population, living along the sand-banks which cut off Lake Saru from the great lake; they are not exposed to fly. The next populated area, the head quarters of Okello, has been dealt with, and the population behind papyrus at miles 44–47. The narrow head of Kadimu Bay is densely infested with fly along its northern shore as far as mile $49\frac{1}{2}$, beyond which, it is lined with a narrow belt of papyrus, which extends along the south coast at about mile 51; behind the papyrus is enough bush to shelter fly.

Locality 24, mile 50.

Fly was taken in the belt of bush at the rate of 21 b.h. The large area of cultivation is interposed between houses lying about half a mile from the water and the fly-belt; the population was estimated at 34 per square mile, but there was probably very little contact indeed, as the watering places were in the low-lying damp land at the head of the Bay, well back from the water, and the lake would only be visited when these water-holes were dry; there were no canoe landings. At one time, there were many more bomas around this bay, and there was sleeping sickness among them during the big epidemic, but there has been none in recent years. It seems, therefore, that slight contact between population at 34 per square mile and fly at 21 b.h. is not dangerous. The next inhabited parts of the coast, Wayendhe, at mile 58–59, and Maresa, at mile 62–63, have been dealt with in Sections IX and X.

Locality 39, mile $66\frac{1}{2}$ at the head of the first bay, south of Siungu point.

Here the shore was sandy, and at a place used for watering cattle, the thin bush along the shore yielded fly at the rate of 10 b.h. The population behind was estimated at just over 30 to the square mile. The people were examined, so far as possible, with negative results, but they seemed in considerable dread of sleeping sickness and sent us off on a wild-goose chase to investigate a reported case two miles away, which turned out to be a septic arm and leg. It is probable, therefore, that we should have heard of any genuine cases of sleeping sickness. A population of 33 per square mile can live safely in contact with fly at rate of 10 b.h.

Locality 41a, mile $69\frac{1}{2}$.

A single boma of people from Mageta was found living close to the water, but with plantations of grain extending almost to the water's edge, and with the belt of bush in front of it cut down so as to interrupt the continuity.

At the edge of the cultivation this belt yielded fly at the rate of 16 b.h.; along the front of the high crops fly was present at the rate of 6 b.h.; averaging 11 for the two places. The frontage of the crops along the water was only about 200 yards, but the inhabitants intended to continue the clearing. They were estimated at 11 per square mile, including several more bomas further back, whose inhabitants made use of the same watering place. Here again we find a small population living safely in contact with a small number of *palpalis*.

Locality 44, mile 73.

A small population at 9 to the square mile existed in contact with fly at rate of 11 b.h., apparently quite safely.

Locality 45a, mile 74.

Just beyond a place where fly existed at the rate of 30 b.h. was a patch of clearing and cultivation down almost to the water's edge, with a thin line of bush in front where fly was taken at the rate of 18 b.h. The population behind was estimated at 56 per square mile; but no evidence could be obtained of sleeping sickness in the neighbourhood; at the time of the epidemic there were many people living near the water.

Locality 47, mile 75.

Between this locality and the last it is noteworthy that fly was found at the rate of 82 per b.h., but at that point the bush was impenetrable, and there is obviously no contact with any population now. At locality 47 fly was present at 4 b.h., with a population of 42 per square mile within a mile of the water, but further away were many more people.

Locality 49, mile $77\frac{1}{2}$.

Although the cover for fly seemed poor, it sheltered *palpalis* at the rate of 38 b.h. There were four bomas about $1\frac{1}{2}$ miles back from the water, and many others further back. The population near the water was estimated at 60 per square mile, but it is doubtful how much they were in contact with the fly along the shore in front. There was no evidence of sleeping sickness in this locality.

Localities 52–54, miles 82–84.

At mile 82–83 there was a fringe of bush along rather a marshy shore, not heavily fly-infested. At mile 84 there was an open beach backed with trees that seemed to make a typical "fly-beach" (Plate vi, fig. 1). But at mile 84 fly was present only at the rate of 4 b.h.; this seemed to be due to narrowing of the forest belt by cultivation behind, for about one mile further to the south-east, where there was no interference on the part of the population (mile $85\frac{1}{2}$), fly was found at 39 b.h.

The population living along the summit of the ridge about one mile back from the shore between miles 82–$84\frac{1}{2}$ was estimated at 72 per square mile. No evidence of sleeping sickness in the locality was obtainable, but it is certain that at mile 84 the beach is much used by canoe men and others, and that were *palpalis* more numerous there the disease *must* occur. Information was obtained that formerly the people had lived much nearer to the water, and that there had been much disease, so that they had been forced to retire further back. We found ample evidence of old cultivation behind the thickly fly-infested part of the beach, at mile $85\frac{1}{2}$.

Locality 56, mile 87.

At a very open part of the shore, where there was a little-frequented banana plantation, fly was present at the rate of 9 b.h. A large population lived at a distance of a mile or more, back from the water, estimated at 50 per square mile or over, but the amount of contact with fly is very doubtful.

Locality 61, mile 92½.

This was particularly interesting as showing how an infested watering place can cause sleeping sickness, even though the population is otherwise well out of reach of the fly. A small bay is bounded on the north-west by a wooded coast yielding fly at the rate of 48 b.h. and on the south by a peninsula yielding 12 b.h. At the head of the bay was a very thin line of bush, behind which a large area of grain fields stretched back for half a mile. At the south end of this area was an open, rocky piece of shore used as a watering place, sheltered by an isolated clump of big trees and bushes. This was separated by about twenty yards of bare rock, from the continuous belt of bush further along the coast. Fly was present in this islet of bush at the rate of 20 b.h., and at the end of the continuous belt at 28 b.h. Within two miles of the water, and on the ridge around the head of the bay, were houses, whose inhabitants (except during the wet months, April–June) go to the above-mentioned watering place and take their cattle there daily. The population per square mile was estimated at 54. Two men and four women were found infected, but apparently quite unaware of the fact ; they had typically enlarged glands. I was told that many people formerly lived along the peninsula to the south, now heavily bushed, but had been driven back by sleeping sickness.

It seems clear from this locality that contact at a watering place between a population of 54 per square mile and fly at 20 b.h. causes sleeping sickness.

Locality 64, mile 97.

Here a much-used landing place was found frequented by canoes coming from Ruzinga Island. There was a comparatively clear space of about fifty yards on the beach with the usual fringe of bush beyond that on the shore on each side, sheltering fly at the rate of 16 b.h.

Fifteen men found on the shore were examined and three had enlarged glands typical of sleeping sickness. In one man the cervical glands were less enlarged than the axillary, which were discrete and soft ; in two other men the enlarged glands felt hard and as if sclerosed, and would have been unlikely to yield trypanosomes on puncture. These cases suggested that the patients had successfully combated the trypanosomes ; they were all healthy-looking men. These men came from a group of twelve bomas situated within a mile of the water and using this watering place ; the population was estimated at 80 per square mile.

Contact between a population of 80 per square mile and fly at 16 b.h. therefore produces sleeping sickness.

Locality 66, mile 100.

A single case of sleeping sickness was found, where one boma of people who came from Ruzinga Island live only about half a mile from the water. There is cultivated land between it and the water. Seven bomas as well were found to use this landing and watering place, the population being reckoned as 35 per square mile, whereas fly was present at the landing place only at six per boy per hour, which seems highly unlikely to cause sleeping sickness. Enquiry from the infected man showed that he customarily visited the shore at a part where fly had been estimated at 32 b.h. for taking fish in traps (Locality 65), and this may very possibly have been the true cause of his infection, which I do not think can be ascribed to the landing place. Twenty-two men and fifteen women were examined with negative results.

XII. Summary and Conclusions.

The epidemic of sleeping sickness in Central Kavirondo was introduced about 1903 from Usoga across a chain of islands, and finally from Mageta Island to the coast of Kadimu close by. Mageta was evacuated, and subsequent return of the population brought back the disease, leading to a second evacuation, second return, and renewal of the disease about 1920–21, leading to final evacuation two years ago.

Glossina palpalis occurs plentifully along the 100 miles of coast examined, between the Sio River and the mouth of the Kavirondo Gulf, except just south of Sio, and in the neighbourhoood of the mouths of the Yala and Nzoia Rivers. Ample evidence was obtained that non-mammalian blood is much preferred to that of the hippopotamus, which was the only source of mammalian blood, except man and cattle at some localities.

No trypanosomes of mammalian type were found in 238 *palpalis* examined.

Glossina brevipalpis occurs in the neighbourhood of Kadimu Bay frequenting the places where hippos sleep in the dense bush. In strong contradistinction from *palpalis*, they much prefer the blood of hippos to that of birds or reptiles. Ample evidence was obtained that in former days the population lived and cultivated along the lake shore in very much closer contact with *palpalis* than at present. The people of their own accord have retired from the lake shore, and only at a few localities is there contact with *palpalis* at watering and landing places, but a great deal of fishing is done all along the coast. There is a desire to return nearer to the water, and this will need watching lest the breadth of contact between fly and people be raised to danger-point. It must be remembered that absence of population for many years has resulted in very dense growth of bush in the country within a mile of the water, and that *palpalis* is possibly even more numerous now that formerly. In view of the absence of *palpalis* behind broad belts of papyrus the population should be encouraged to return to those parts in preference to others, *e.g.*, the northern part of Kadimu Bay and the bay running eastwards from the south of Kadimu Bay. Elsewhere safety may be conferred on the general population by clearing all landing and watering places for 200 yards along the coast on each side of the actual landing, and for 50 yards back from the water. To ensure that infected fishermen do not carry the disease from one place to another a system of licences, only valid after certification that the applicant is free from signs of sleeping sickness, could be adopted.

It was not found practicable to examine the lake shore population systematically, nor was it considered expedient, for several reasons, to clinch diagnosis by gland puncture. After the existence of trypansomes in the first case had been thus proved diagnosis depended upon palpation of cervical and axillary glands. No cases were seen so advanced as to be obvious to the eye alone, and the majority of the several cases diagnosed seemed in their own opinion in good health. Only two of the emigrants from Mageta Island showed tremors of the tongue and some degree of wasting. So far as could be ascertained by enquiry, the disease is quiescent at the present time, the only deaths reported being among the Mageta people who had come away two years ago.

The presence of these infected people in a settlement on the mainland in close contact with Jaluo natives of whom none have acquired the disease is strong evidence that agents other than *Glossina* are not of material importance in the epidemiology of the disease. It was thought possible at one locality named Ndiwo, where *Glossina* was reported to be unknown, that sleeping sickness must have been carried by some other agent, but close attention to local conditions and their history in the past showed that there was ample evidence that at the time of the epidemic *palpalis* was probably there in adequate numbers, although barely able to exist at the present day.

The population was found to be living so as to be in contact with *palpalis* at landing and watering places in 20 localities along the 100 miles of coast examined, but in

three of these (24, 49, 56) the degree of contact was so doubtful that it is better not to consider them. In one locality (Maresa) the cases were, with one exception, probably old infections before leaving Mageta Isle, or else due to recent visits to that island; the exception was probably infected owing to residence in a densely fly-infested area close to the water during the famine period and may very possibly have been infected by the cyclical method.

In three of the other localities where infection was discovered (these are all italicised in the list of localities), the relations between the population within $1\frac{1}{2}$–2 miles of the water, estimated as adults per square mile (P), and the number of fly estimated by the catch of males per boy hour (F), are given below as P : F.

Locality 14	... ...	P : F :: 50 : 24.
,, 61	... ...	P : F :: 54 : 20.
,, 64	... ...	P : F :: 81 : 16.
Mageta Isle	... ...	P : F :: 42 : 30.

The data for Mageta Isle are those of the last epidemic, which began probably in 1919, and was seen by Dr. Beven in 1921–22. In Locality 66 the infection was probably not acquired at the general landing and watering place.

The four cases above cited therefore seem to show that broad contact between a population of density over 40 per square mile and *palpalis* at the rate of more than 15 males per boy per hour conduces to infection by *T. gambiense.*

I am indebted to the Hon. The Principal Medical Officer, Uganda, for permission to publish this report, and to the Hon. The Principal Medical Officer of Kenya and the Administrative Officers of Kisumu for help kindly given.

Entebbe, July 1924.

Fig. 1. Beach at Locality 54. A mass of papyrus has floated to the shore from the Kavirondo Gulf.

Fig. 2. At Ndiwo, Yala River; the dried-up swamp with clumps of wild date palms.

SOUTH AFRICAN OFFICIAL ENTOMOLOGISTS.

CONFERENCE OF OFFICIAL ENTOMOLOGISTS, PRETORIA, 12TH–14TH AUGUST 1924.

We have pleasure in reproducing (Plate vii) a photograph of the South African Economic Entomologists who attended the Conference recently held in Pretoria. Their names are as follows :—

Front Row, left to right.—G. A. H. Bedford (Division of Veterinary Education and Research) ; C. B. Hardenberg (Department of Agriculture, Lourenço Marques, P. E. A.) ; C. P. Lounsbury (Chief of Division of Entomology) ; C. Fuller (Assistant Chief of Division of Entomology) ; Dr. F. W. Pettey (Elsenburg School of Agriculture).

Second Row, left to right.—R. W. E. Tucker (Division of Entomology, Capetown) ; Dr. T. J. Naudé (Division of Entomology, Pretoria) ; C. P. van der Merwe (Division of Entomology, Durban) ; Professor Dr. C. K. Brain (University of Stellenbosch) ; S. J. du Plessis (Grootfontein School of Agriculture) ; Professor J. C. Faure (Transvaal University College) ; H. K. Munro (Division of Entomology, East London); R. O. Wahl (Potchefstroom School of Agriculture) :

Third Row.—Dr. J. T. Potgieter (Glen School of Agriculture) ; Dr. L. B. Ripley (Cedara School of Agriculture) ; B. Smit (Grootfontein School of Agriculture).

Top Row.—Dr. A. E. Lundie (Division of Entomology, Pretoria) ; G. C. Haines (Division of Entomology, Pretoria) ; D. Gunn (Division of Entomology, Port Elizabeth).

COLLECTIONS RECEIVED.

The following collections were received by the Imperial Bureau of Entomology, between 1st April and 30th June, 1924, and the thanks of the Managing Committee are tendered to the contributors for their kind assistance :—

Dr. G. Arnold, Rhodesia Museum :—34 Diptera, 73 Coleoptera, and 3 Orthoptera; from Rhodesia.

Mr. T. J. Anderson, Government Entomologist :—6 Tachinidae and 10 Lepidoptera ; from Kenya Colony.

Prof. H. A. Ballou :—4 Tabanidae, 21 other Diptera, 130 Coleoptera, 59 Hymenoptera, 80 Lepidoptera, 47 Rhynchota, and 20 Orthoptera ; from Trinidad.

Mr. P. J. Barraud :—60 Coleoptera ; from Punjab, India.

Dr. C. F. C. Beeson, Forest Zoologist :—150 Coleoptera ; from Dehra Dun, India.

Mr. A. O. Blackhurst :—2 species of Coccidae ; from Smyrna, Asia Minor.

Mr. G. E. Bodkin, Agricultural Entomologist, Department of Agriculture and Fisheries :—3 Oestrid larvae, 2 Asilidae and their prey, 11 other Diptera, 33 Coleoptera, 271 Braconidae and a number of cocoons, 18 other Hymenoptera, 11 Rhynchota, 6 Orthoptera, and 14 Ticks ; from Palestine.

Prof. V. F. Boldyrev :—48 Orthoptera ; from Russia.

Dr. G. Bondar :—42 Coleoptera, 3 Chalcididae, 6 Microlepidoptera and 8 larvae, 8 Rhynchota, 100 Psocidae, and 50 Mites ; from Brazil.

Mr. E. R. Buckell :—46 Orthoptera ; from British Columbia.

Dr. P. A. Buxton :—2 Siphonaptera, 2 Psychodidae, 3 Culicidae, 33 Tipulidae, 59 other Diptera, 103 Coleoptera, 51 Formicidae, 28 other Hymenoptera, 473 Lepidoptera, 11 species of Coccidae, 148 other Rhynchota, 67 Orthoptera, 24 Odonata, and 16 Mallophaga ; from Samoa, etc.

Mr. G. S. Cotterell :—5 Tabanidae, 66 other Diptera, 159 Coleoptera, 43 Hymenoptera, 25 Lepidoptera, 5 species of Coccidae, 53 other Rhynchota, and 15 Orthoptera ; from the Gold Coast.

Prof. R. E. Danforth :— 3 Curculionidae ; from Porto Rico.

Director of Agriculture, Baghdad :—2 Microlepidoptera and 1 species of Coccidae ; from Iraq.

Division of Entomology, Pretoria :—60 Chalcididae ; from South Africa.

Prof. J. C. Faure :—270 Coleoptera ; from South Africa.

Dr. E. W. Ferguson :—40 Tabanidae ; from the Malay Archipelago and South Asia.

Mr. T. Bainbrigge Fletcher, Imperial Entomologist :—492 Curculionidae ; from India.

Mr. C. C. Gowdey, Government Entomologist :—3 Diptera, 7 Coleoptera, 29 Hymenoptera, 178 Lepidoptera, 17 species of Coccidae, and 94 other Rhynchota ; from Jamaica.

Mr. W. B. Gurney :—915 Ticks ; from New South Wales, Australia.

Mr. H. Hargreaves, Government Entomologist :—12 Diptera, 636 Coleoptera, 160 Parasitic Hymenoptera and 6 cocoons, 29 other Hymenoptera, 89 Lepidoptera, 186 Rhynchota, 34 Orthoptera, 8 Anoplura, and 429 Ticks ; from Uganda.

Mr. P. Harwood :—27 Curculionidae ; from India and Iraq.

Mr. W. E. Higgs :—1 species of Aleurodidae ; from the Bahamas.

Mr. G. F. Hill :—4 Isoptera ; from Australia.

Mr. G. V. Hudson :—646 Coleoptera ; from New Zealand.

Mr. M. Afzal Husain, Government Entomologist :—11 Diptera, 9 Coleoptera, 100 Parasitic Hymenoptera, and 3 other Hymenoptera ; from the Punjab, India.

Imperial Institute, London :—5 Coleoptera ; from Tanganyika Territory.

Indian Museum, Calcutta :—5,083 Coleoptera, 99 larvae and 21 pupae ; from India.

Mr. R. W. Jack :—100 Chalcididae ; from Rhodesia.

Mr. E. Jacobson :—253 Coleoptera ; from Sumatra.

Mr. E. Jarvis :—6 Lepidoptera ; from Queensland, Australia.

Mr. F. P. Jepson :—73 Coleoptera and 33 early stages, and 3 Thysanoptera ; from Ceylon.

Mr. C. R. Kellogg :—253 Coleoptera ; from China.

Mr. C. B. R. King :—8 Culicidae, 5 other Diptera, and 11 Lepidopterous larvae and 2 pupae ; from Nyasaland.

Dr. I. J. Kligler :—6 Tabanidae, 4 Hippoboscidae, 46 other Diptera, 47 Coleoptera 3 Rhynchota, and 2 Orthoptera ; from Palestine.

Dr. W. A. Lamborn, Medical Entomologist :—34 Siphonaptera, 14 Culicidae. 3 larvae and 8 pupal skins, 20 Anoplura, and 6 tubes of Algae ; from Nyasaland.

Mr. S. F. Light :—1 Beetle ; from China.

Mr. G. A. Mavromoustakis :—4 Diptera, 12 Coleoptera, 8 Hymenoptera, and 25 Orthoptera ; from Cyprus.

Mr. D. Miller, Government Entomologist :—2 Coleoptera and 7 Lepidoptera ; from New Zealand.

Mr. H. K. Munro :— 10 Diptera ; from South Africa.

Museum National d'Histoire Naturelle, Paris :—239 Orthoptera ; from North Africa.

National Museum, Melbourne :—41 Culicidae and 2 larvae, 16 Chironomidae, 12 other Diptera, 20 Coleoptera, 7 Formicidae, 4 Lepidoptera, and 2 spiders ; from Australia.

Mr. L. Ogilvie, Plant Pathologist :—36 Diptera and 6 pupa-cases, 24 Coleoptera, 19 Parasitic Hymenoptera, 5 other Hymenoptera, 97 Lepidoptera, 4 species of Coccidae, 2 species of Aleurodidae, 2 species of Aphididae, 18 other Rhynchota, 2 Orthoptera, and 2 Centipedes ; from Bermuda.

Dr. W. Ramme : —101 Orthoptera ; from Europe and Asia.

Mr. Y. Ramachandra Rao :—12 Coleoptera ; from South India.

Mr. A. Reyne :—4 Formicidae and 2 species of Coccidae ; from Dutch Guiana.

Mr. A. H. Ritchie :—4 Coleoptera ; from Jamaica.

Mr. H. W. Simmonds, Government Entomologist :—3 Hippoboscidae, 131 other Diptera, 71 Coleoptera, 57 Hymenoptera, 20 Lepidoptera, 59 Rhynchota, and 4 Spiders ; from Fiji, etc.

Capt. C. Smee, Government Entomologist :—116 Tabanidae, 130 other Diptera, 12 larvae and 16 pupae, 322 Coleoptera and 16 larvae, 7 Coleopterous larvae attacked by fungus, 329 Parasitic Hymenoptera, 80 other Hymenoptera, 76 Lepidoptera and 70 early stages, 131 Rhynchota and 3 nymphs, 35 Isoptera, 8 Odonata, 8 Embiidae, 4 Hemerobiidae, 4 Perlidae, 5 Myrmelionidae, 2 Nemopteridae, 3 Mallophaga, 2 Anoplura, 7 Tick nymphs, 23 Mites, 23 Millipedes, and 2 Scorpions ; from Nyasaland.

Dr. V. G. L. van Someren :—31 Culicidae, 7 larvae and 2 pupae ; from Kenya Colony.

Mr. H. P. Thomasset :—42 Culicidae, 3 Tabanidae, 492 other Diptera, 277 Coleoptera, 151 Hymenoptera, 212 Lepidoptera, 162 Rhynchota, 5 Orthoptera, 8 Trichoptera, 9 Planipennia, and 50 Mites ; from Natal.

Dr. R. J. Tillyard :—15 Forficulidae ; from New Zealand.

Mr. F. W. Urich :—28 Coleoptera, 4 Rhynchota and 3 nymphs, 2 Orthoptera, 10 Ephemeridae, 2 Spiders, and 6 *Steatornis caripensis* embryos ; from Trinidad and New Guinea.

Wellcome Tropical Research Laboratories :—18 Diptera, 33 Coleoptera, 32 Parasitic Hymenoptera, 45 Lepidoptera, 440 Isoptera, and 2 Thysanoptera ; from British Sudan.

Mr. D. S. Wilkinson, Government Entomologist :—2 species of Coccidae ; from Cyprus.

Mr. C. B. Williams :—2 Lepidoptera ; from Egypt.

Mr. C. L. Withycombe :—225 Pyrrhocoridae ; from Trinidad.

Mr. G. N. Wolcott :—23 Coleoptera, 4 Rhynchota, and 6 Lizards ; from Porto Rico.

Mr. A. V. Znamensky :—516 Parasitic Hymenoptera ; from Poltava, Russia.

AUSTRALASIAN SIMULIIDAE.

By A. L. Tonnoir,
Research Student on Diptera, Cawthron Institute, Nelson, N.Z.

Introduction.

On coming to New Zealand with the object of studying Diptera in general, I was asked by Professor Easterfield and Dr. R. J. Tillyard, of the Cawthron Institute, to direct my attention specially to the very aggressive " sandflies " of this country, and to try to gather as many facts as possible concerning their biology, which could eventually serve as a basis for a possible control of this pest.

I made, therefore, as many observations as I could during the summer of 1921–22 in the South Island of New Zealand, and these were continued in the North Island during a part of the summer of the following year. During this same summer, in the course of a sojourn of four months in Tasmania and the Australian mainland (parts of which I had previously visited), I had the opportunity of collecting, breeding and studying a fair number of species.

These investigations prove that, although not much was known concerning the Simuliidae of the Australasian region, they are quite as numerous as in other parts of the world, both in the number of species and in the number of individuals.

In such a relatively short space of time I am, of course, far from having exhausted the question ; it is probable that more species are awaiting discovery, and that many more facts about their biology have yet to be brought to light. However, I think it is worth while publishing the results obtained so far, as they will help to clear the ground and give a basis for further study of these interesting Diptera. Twenty-one species are dealt with in this paper, of which fifteen are new, and the early stages of a good number have been studied in all their phases.

I am very much indebted to Dr. E. Ferguson, of Sydney, for the loan of specimens from New South Wales, to Mr. A. Musgrave and Mr. J. A. Nicholson for the loan of paratypes of Skuse's species, to Mr. A. Philpott and his friends, Messrs. R. Murrell, C. C. Fenwick and G. Jaquiery, who procured me New Zealand specimens from localities I had no opportunity of visiting myself, and to Mr. G. Archey for lending me specimens from Capt. Hutton's collection in the Canterbury Museum. My best thanks are due also to Mrs. M. Bisley and Mr. A. Philpott for reading through the text of this paper.

Localities Visited.—In the South Island, the neighbourhood of Nelson, which has been my place of residence, has been specially investigated ; then the West Coast as far down as the Waiho River ; along the road from Greymouth to Christchurch by way of the Otira Gorge and up the East Coast from Christchurch. Further material has been received from Dunedin, Central Otago, Invercargill and the Sounds District.

In the North Island, the Waitakerei Ranges north of Auckland and the vicinity of that town ; Te Aroha and the volcanic district near Rotorua and Wairakei ; Ohakune ; and Wellington.

In New South Wales : Narara, near Gosford, and Woy Woy. In the Blue Mountains, Wentworth Falls and Mt. Wilson. The material received from Dr. Ferguson contained also specimens from Canoblas, Bumberry, Dawson River and Sydney.

In Queensland : Eidsvold (coll. Ferguson).

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In Victoria : Fern Tree Gully and Sassafras on Mt. Dandenong.

In South Australia : Mt. Lofty (coll. Ferguson).

In Tasmania : An extensive portion of this island has been covered, the chief localities visited being the vicinity of Hobart and Mt. Wellington, Geeveston, the Hartz Mountains, the Tasman Peninsula, Bruny Island, the National Park and Mt. Field, the vicinity of Launceston, St. Patrick River, Burnie, Cradle Valley and different spots on the West Coast : King River, Mt. Farrel, Strahan, etc.

Historical.

Hitherto six species of SIMULIIDAE from Australasia have been described. First, in 1869, Schiner, in his report on the Diptera collected by the frigate " Novara " during her voyage round the world, mentioned one species under the name of *Simulia australensis*.* The very short and inadequate description was made from two rather defective female specimens collected near Auckland (N.Z.) and still preserved in the collection of the Vienna Museum. The same species is mentioned again by Hutton in his catalogue of New Zealand Diptera† under the wrongly modified name, *S. australiensis*, where he gives a simple translation of Schiner's description, but in his diagnosis of the genus he counts 11 joints in the antennae, although no New Zealand species has more than 10. In 1881 Mik described a second species under the name of *Simulium vexans*,‡ collected in the Auckland Islands, which are part of the New Zealand territory ; this form was as poorly described as that of Schiner, but seems to differ from it by the colouring of the legs.

In Australia Skuse found two species which he described under the names of *Simulium furiosum*§ and *S. ornatipes*.‖ These two forms are rather well described, and the types are still in the Sydney Museum and the Macleay collection. In an account of the known Dipterous fauna of Australia Skuse mentions erroneously one species of *Simulium* under the name of *molestum*,¶ meaning probably *S. furiosum*. He does not mention their blood-sucking habit, though the name he gave to the latter species undoubtedly suggests it.

Somewhat later G. V. Hudson, in his Manual of New Zealand Entomology (1892), gives under the heading of the family TIPULIDAE (?) an account of the life-history of a species that he assumed to be *Simulium australense*, but which might be any one of the six species of the country, his description of the early stages being too vague and his drawings not quite accurate. Besides, some errors have crept into the account ; the larvae are not, as he says, provided with two pairs of suckers, and they do not breathe through hind spiracles ; in fact, they do not differ from the forms found elsewhere except in very slight details of structure. The breathing organ of the pupa (Pl. vi, fig. 1*a*), if accurate, is of a type unknown to me, so that I am at a loss to say which species Hudson had before him when he made his description and drawings.

A few years afterwards Prof. P. Marshall returned to the question of the New Zealand sandfly.** His account of the life-history of *Simulium australense* is taken mostly from Hudson ; among the few original remarks two must be pointed out as not being true to fact ; the larvae are not carnivorous, and they do not make any discrimination in their food, simply swallowing what is caught in their mouth-fans.

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*Reise der Oesterreichen Fregatte Novara um die Erde. Zoolog. Theil., Band II. 1ste Abt. p. 15, 1868.

† Catalogues of the New Zealand Diptera, Orthoptera, Hymenoptera. Wellington, 1881, p. 19.

‡ Verh. zool. bot. Ges. Wien, xxxi, 1881, p. 201.

§ Proc. Linn. Soc. N.S.W. (2) iii, 1889, p. 1365.

‖ Ibid. v, 1890, p. 632.

¶ Rept. Second Meeting Austr. Assoc. Adv. Science, 1890, p. 528.

** Trans. N.Z. Inst., xxviii, 1895, p. 310.

Further he says : " A cocoon is formed before pupation of membranous or gelatinous material *which is afterwards eaten almost entirely.*" By what—by the pupa or the imago ? Neither of them could do it, for they lack the adequate mouth-parts. His description of the adult fly is only a translation of the one by Schiner. However, after the diagnosis of the genus *Simulium* he mentions specially that *S. australense* differs by the number of antennal joints, which is 10 instead of 11.

In his report on a small collection of Diptera from the Southern Islands of New Zealand,* Capt. Hutton gives a translation of Mik's description of *S. vexans*, which species he himself collected in the Auckland Islands, and he notes that it is different from *S. australense.*

In 1906 E. Roubaud described a new species from Victoria† that was in the collection of the British Museum. As this approximately accurate description is based on the female sex only, and as the early stages are not yet known, it is difficult to be sure if this is a good species ; the females, and sometimes the males also, of most of the Australian species being so little different from each other, the description could apply to *S. furiosum.*

Under the curious heading " Phlebotomic Diptera "‡ F. H. Taylor describes a species, *S. bancrofti,* which is reported to bite man.

This was the extent of our knowledge of the Australasian SIMULIIDAE when I started their study at the end of 1921. Since then I have published a note§ on the manner in which the larvae progress and fix themselves to their supports, and how one of the New Zealand species builds its cocoon.

Bionomics.

The eggs of only one species were observed and hatched out. I refer them to *A. tillyardi*, sp.n., a New Zealand species which breeds mostly on river shingle. These eggs were found at the beginning of the spring (September) on the lower side of a good-sized stone at a depth of four inches of water ; the egg-batches were disposed on the stone in more or less rectangular plates of about 7 by 4 mm. ; the recently laid batches were yellow in colour, the oldest dark ochraceous ; they consisted of a single layer of eggs placed very regularly one beside the other, and all united and fixed to the stone by a transparent gelatinous mass. Each egg is more or less oval in shape, somewhat flattened and with a hump on one side which makes it appear triangular when seen on its broader face, the angles being, of course, very much rounded ; its dimensions are 0·126 by 0·189 mm. All the eggs hatched fourteen days after they had been collected. The hatching out of the young larva takes place through a slit that extends from the apex of the lateral hump to the narrower end of the egg.

The newly hatched larva differs but little from the full-grown one and behaves in exactly the same way as regards displacement and feeding. I have recently given an account of the manner in which the larva moves about and fixes itself to the stones or plants on which it lives. The attachment is effected, not by means of suckers as was supposed, but by means of a glutinous matter that the larva deposits on the crown of hooks at the end of its body each time it changes its place ; and this is probably true also for the species in other parts of the world. When the larva is moulting, the skin breaks round the neck and the detached old head-capsule is carried away by the current. The larva then fixes its head on the support, and simply walks out of its old skin.

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* Trans. & Proc. N.Z. Inst. 1901, xxxiv, p. 169.
† Bull. Mus. Hist. nat. Paris, vii, p. 521.
‡ Austr. Zoologist, i, pt. 6, p. 167.
§ Ann. Biol. lac., Bruxelles, 1922.

Simuliid larvae are to be found either on stones or on aquatic plants, according to the species, but only where the speed of the current is about one foot per second. Some species thrive only in the rush of a waterfall or in the rapids of a river ; but the larvae in their early stages do not seem to require such a strong current.

The lapidicolous species select in preference a clean stone without moss growth and seem to have a predilection for lighter-coloured stones.

The water cress (*Nasturtium officinale*) is a plant usually chosen by the herbicolous species as a support, and they generally fix themselves on the underside of the leaves ; some aquatic grasses, the long blades of which are waving continuously under the action of the current, provide one of their favourite haunts ; so, also, do the blades of ordinary grass or even the twigs of trees like weeping willows that dip into the water on the edge of the stream. Sometimes the larvae content themselves with dead leaves or bits of dead reeds and wood caught between the stones of a cascade.

Some herbicolous species do not seem to be able to adapt themselves to living on stones, at least I never happened to find them in such situations ; but the contrary is not true, as some species that live on stones may occasionally be found on aquatic plants. The lapidicolous or herbicolous habit of the larvae is the great factor, together with the speed of the current, which influences the distribution of the species.

Most of the large streams of New Zealand and Tasmania have a rocky or shingly bottom without any aquatic vegetation ; it is therefore almost exclusively in the small streams and rivulets that the herbicolous species are met with.

The larvae of SIMULIIDAE may be found all the year round in the streams and rivers of Australasia ; they overwinter in that stage, but where the winter is mild enough, they go on breeding during that season. However, the relative scarcity of pupae found then shows that there is a serious retardation in their life-cycle.

During the warmest months these larvae are seen in innumerable quantities, especially the species living on stones, on which they are usually very regularly disposed ; this arrangement is due to the fact that no larva tolerates one of its congeners in its immediate vicinity, and sweeps away with its head all that come within its reach. When an intruder settles within range of another larva, a fight takes place which may last quite a long time, each larva trying to make its opponent release its hold on the stone, chiefly by pinching it near the extremity of the body until the weaker one retreats.

The feeding of the larva is quite passive, and there seems to be no discrimination made in its food, which consists mainly of the miscellaneous particles in suspension in the water. When feeding, the larva remains motionless but for the vibrations caused by the action of the current ; the body is so twisted that its ventral side is oriented dorsally in its anterior part ; the mouth-brushes, being thus kept wide open by the current, retain all the particles that happen to run into them ; then from time to time the fans are closed and cleaned with the mandibles, the whole catch being swallowed.

The duration of the whole life-cycle varies with the season. In New Zealand species, which have been watched closely, it appears to be on an average 6–7 weeks during the summer months, about 12 days being passed in the pupal stage. The number of larval moults has not been definitely ascertained, but it is certainly not less than four.

When ready to pupate the larva usually selects some sheltered spot, some hollow or crevice, or the underside of the stone. It seems then to show some sign of negative phototropism, but remains preferably where the current is strong. The larvae living on plants nearly always go on the underside of the leaves to pupate, but those fixed on the round stems of aquatic grass build their cocoons on the same spot where they have probably spent their whole life.

I have already described in detail the construction of the cocoon of one New Zealand species.* Since then some observations have been made on another species, the method of which differs noticeably, the cocoon being completely closed and only opened subsequently in front by means of the breathing organs of the pupa, which revolves several times on itself after metamorphosis. In such species as *Austrosimulium torrentium,* the cocoons of which are quite flat, and in others that are provided with one or two anterior projections, the method of building must differ considerably, and an exact account of their construction should prove highly interesting.

The time of day favoured by the larva for the building of the cocoon is about midday, during the warmest hours, and the emergence of the adults usually takes place about the same time.

When imagines are obtained from pupae by breeding, approximately equal numbers of males and females are observed to emerge, but in nature they are not met with in equal numbers. It is true that owing to the fact that the males are not bloodsuckers they are not attracted to man, but even when searching for them, with the exception of one or two species, they are always hard to find, and in some cases are never encountered. For instance, as regards New Zealand species, I have never found a single male in sweeping with the net on grass or plants along streams, although the females were frequent in such situations. All the males I have in my collection were obtained from pupae. Their life is not specially short, as I succeeded in keeping alive some of the bred specimens for two days ; therefore I think it very probable that they fly very high up immediately after emergence, and swarm and dance in the air out of the observer's reach, resting only on the tree-tops. The females are only on the wing during the day, their greatest activity being during the warmest hours, or before and after rain when the air is saturated with moisture. During the summer they are active after sunset in the twilight, but not during the night, even if it be a clear one. In New Zealand they are often observed in houses, provided that the rooms are not too dark ; they are never found in dense bush, but only on the edges, in the clearings and in large open spaces ; they sometimes wander very far from their breeding places and frequent preferably the banks of lakes, sea-beaches, or the high tussock plateaux up to 4,000–4,500 feet, which seems to be the altitude limit of their habitat. In New Zealand (and to a certain extent in Tasmania also) there is no open place where one can sit without being the object of their attacks at all times of the year in places where the winter is somewhat mild. All the New Zealand species may not be blood-suckers ; it happened once that when I was collecting larvae and pupae of a species (*A. multicorne*) in a small stream on the Mt. Arthur plateau (4,000 ft.), the adults were flying round me in great numbers ; several alighted on my bare arms but did not attempt to bite, although I gave them every opportunity of doing so ; the only specimen that did, when captured, proved to belong to another species, *Austrosimulium ungulatum.* In similar circumstances, when collecting the early stages of *A. laticorne* in South Westland, all the specimens captured in the act of biting were *A. ungulatum,* although the adults of the former must have also been about on account of the great number of hatched pupae. However, *A. ungulatum* is not the only New Zealand species which bites man, as many specimens were caught in the act of biting which belonged to the group with simple claws ; unfortunately I have been unable so far to differentiate them in the adult stage, and am therefore at a loss to discriminate between the biting and non-biting species of that group.

During the breeding experiments that I have been carrying out at the Cawthron Institute, I had an aquarium cage in which the emerged flies could sojourn in a rather large, well-aerated space ; but they never attempted to bite my arm, which I used to introduce into the cage through a sleeve, whatever length of time I left it in at

* Ann. Biol. lac. 1922.

any hour of the day; the species in this case was *A. tillyardi*. However, I do not consider this fact conclusive, because it is well known that some biting insects, when kept in captivity, cannot be induced to bite. Another experiment was carried on with *A. australense*; the flies emerging were set free in the laboratory, and although they were sometimes quite numerous on the window-panes, they did not attempt to bite me; but in this case also the conditions were not quite normal. On the other hand, this same species was the only one I found in the river at Te Aroha in the vicinity of which the adults were very troublesome.

The literature contains the record of only one biting species in Australia, *A. bancrofti*, Taylor, although, as already stated, the name given by Skuse to another species, *A. furiosum*, seems to suggest a blood-sucking habit that he does not mention otherwise. No doubt can exist that a certain number of other species are also blood-suckers; Dr. Ferguson's collection contained specimens of two, *S. terebrans*, sp.n. and *S. fergusoni*, sp.n., which were labelled "biting man," both coming from New South Wales; and I was bitten myself by *S. terebrans* in Victoria. However, except perhaps in Queensland, whence I have no record, the species of SIMULIIDAE of the Australian mainland are not conspicuous by their thirst for human blood; and the name of "sandflies" is there bestowed on some species of CERATOPOGONINAE. On the other hand, the flies known in Tasmania under that name are SIMULIIDAE and are said to be exceedingly troublesome in some parts, especially where *S. torrentium* lives. I was never bitten myself there, although engaged in researches on these flies, and therefore very often in places where they could be found and observed easily. On several occasions I collected specimens of *A. tasmaniense*, which were flying about my face and hands, but without making any attempt to bite. It is true that the summer I spent in Tasmania was so chilly and wet that my observations were not made under normal conditions, and so cannot be considered conclusive.

The geographical distribution of the species is a question that could only be adequately attempted with some degree of accuracy after many years of research; consequently the following lines profess to give only a few general observations on the subject. Only two genera are considered in this paper, the world-wide *Simulium*, and a new one, *Austrosimulium*, which seems to be found only in the Indo-Australian region. The genus *Simulium* does not occur in New Zealand. Up to now no species have been found to be common to Australia and New Zealand, but a curious parallelism exists between the SIMULIIDAE of this latter country and those of Tasmania. In both countries about half a dozen species of *Austrosimulium* occur, which, except for one species in each case with toothed-clawed females, are practically indistinguishable from each other in the adult stage, whereas their pupal stages are easily distinguishable by the peculiarity of structure of the breathing organs, or often also by the conformation of the cocoon. However, in New Zealand the majority of the species are herbicolous, whereas in Tasmania they are lapidicolous. None is common to both countries. On account of this difficulty of distinguishing the species in the imaginal stage, the study of the geographical distribution of the SIMULIIDAE should be preferably based on the pupae, which are readily found in the streams, or on the larvae in their last stage, when they show the pupal breathing organ already sufficiently developed.

In New Zealand there are species that have not yet been found in the North Island; these are *A. ungulatum* and *A. laticorne*, whereas all the known species inhabit the South Island (with the exception of *A. vexans*, peculiar to the Subantarctic Islands), but *S. australense* has not yet been found further south than the Kaikoura district. In a general way one can say that *S. australense* is the prevalent species in the North Island, whereas *A. ungulatum* is the prevalent one in the South Island.

Regarding Australia, it is more difficult to give accurate data on the distribution of species, so little being yet known about them. *S. aurantiacum* and *A. cornutum* have a range from New South Wales to Tasmania; *A. crassipes* and *S. umbratorum*

have been found so far only in Victoria ; *S. fergusoni* and *S. ornatipes* only in New South Wales ; *S. bancrofti* only in Queensland ; whereas *S. terebrans* is common to Victoria and New South Wales, and *A. cornutum* to Victoria and Tasmania. The distribution of the Tasmanian species has been somewhat more closely surveyed. All the six species but one found there up to now seem to be peculiar to the island ; *A. tasmaniense* is the prevalent one and is recorded from all parts of the country and at all levels ; *A. cornutum* and *S. aurantiacum* are also widespread but rather uncommon ; this last is limited to the spots where the current of water is fast enough to suit the requirements of its larva. *A. torrentium* has only been found in the north, north-west and centre ; *A. weindorferi* in the centre and *A. simile* in the south.

Several species are, of course, often found in association, and I give hereafter a few of the observations I made on this point based on the pupae collected in the same spots.

In New Zealand :—

1. *A. australense, A. tillyardi*—Poor Man's Creek, Nelson.
2. *A. tillyardi, A. laticorne*—Maitai, Nelson.
3. *A. australense, A. longicorne, A. multicorne*—Ohakune.
4. *A. longicorne, A. australense*—Kaikoura.
5. *A. laticorne, A. multicorne, A. longicorne*—Waiho, large stream.
6. *A. laticorne, A. multicorne*—Waiho, small creek.

In Tasmania :—

1. *A. cornutum, A. tasmaniense*—St. Patrick River, small creek.
2. *A. tasmaniense, A. torrentium*—St. Patrick River.
3. *A. simile, A. tasmaniense*—Geeveston, Brown River.
4. *A. simile, S. aurantiacum*—Adventure Bay.
5. *A. cornutum, A. tasmaniense, S. aurantiacum*—Russell Fall and Crater Creek, Cradle Mt.
6. *A. torrentium, S. aurantiacum*—Mt. Farrel.
7. *A. weindorferi, A. tasmaniense, A. torrentium*—creek, Lake Lilla, Cradle Mt.

Adults.

With two or three exceptions the Australasian SIMULIIDAE do not present very well marked characters of differentiation between the species. First of all, their coloration is uniformly blackish grey in all parts of the body, only a couple of species showing some orange colouring on some parts of the legs, and another species being mostly bright orange. In the males the mesonotum is velvety black without bright silvery markings, as in holarctic species, and carries a golden, bronzy or sometimes brown, short pubescence, usually moderately dense ; in the females the notum is blackish grey with a uniform yellowish or silvery pubescence ; in one species only this pubescence is bi-coloured and disposed in bands. The anterior part of the pleurae is nearly always more or less silvery grey and more distinctly so in the males. The halteres are usually whitish, but sometimes also orange or brownish, according to the species. The conformation of the head in the males is the same throughout the species ; there is no gradual transition between the large-facetted region of the eyes and the small-facetted region, the limit between them being a horizontal line at the level of the base of the antennae. In the female the frons is more or less wide accord-

ing to species, and its sides are either parallel or divergent ; it presents sometimes a more or less well-marked median longitudinal furrow.

The antennae are either eleven or ten-jointed, these numbers being the same in both sexes of a given species ; the relative length of the different joints is often of some taxonomic importance ; in the males the third joint is always relatively longer than in the females, and so is the second in most cases ; in both sexes the fourth is small, whereas the following ones usually increase in length towards the extremity of the antennae ; the last joint is always more or less elongated with its extremity tapering in an ogive.

The palpi are composed of five joints, the relative lengths of which afford sometimes a good specific character ; the third joint, which carries an internal sense organ, is more or less incrassate and somewhat flattened laterally, especially in the female ; the fourth is always a little produced on the internal distal end, which overlaps the base of the fifth ; this one is usually thinner and longer than the others ; sometimes it is more or less club-shaped ; there seems to be no sexual dimorphism in the structure of the palpi.

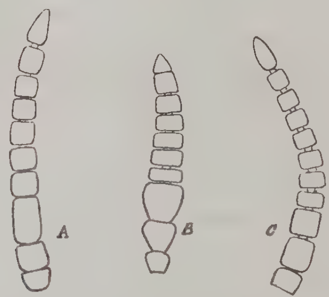

Fig. 1. Antennae of (A) *Austrosimulium tasmaniense*, sp. n. ; (B) *A. bancrofti*, Tayl. ; (C) *Simulium umbratorum*, sp. n.

The mouth-parts are more developed in the female, but are composed of the same parts in both sexes ; however, the labium of the male does not carry at its tip the two small groups of teeth which are to be found in the female ; on the other hand, although not a bloodsucker, its mandibles are relatively just as well developed, as are the galea, which are also delicately serrated on their edges ; the lacinia is not present in either sex.*

The vestiture of the head is little conspicuous, the face and frons carrying only a few mostly yellowish hairs and the vertex some black bristly hairs ; sometimes in the female the rather long hairs of the occiput are extremely dense.

The hairs of the mesonotum are short, adpressed, of a metallic nature and of uniform length, at least on the disk, those around the shoulders, on the sides and in front of the scutellum being sometimes longer ; the space in front of the scutellum carries besides some longer black hairs like those that are to be found on the edge of the scutellum.

* What A. Peterson (Illin. Biol. Mon. iii, no. 2) describes as the lacinia in *Simulium* seems to be not a true appendage but a chitinous rod imbedded in the integuments and uniting the base of the palpi with the base of the hypopharynx.

The anterior legs of all the Australasian species are thin, neither the tibiae nor the tarsi being flattened or incrassate ; the front tarsi are noticeably longer than the corresponding tibiae, whereas in the middle legs they are subequal to their tibiae ; this difference is a little more marked in the male. The best taxonomic characters are given by the hind legs, which are conspicuously stouter and longer than the anterior ones, their metatarsi being always very elongated, nearly as long as the tibiae and always flattened ; with one exception they are never wider than the tibiae ; their distal end on their interior face is produced into a kind of flap, more or less developed and more or less wide according to the species ; in some it is as wide as the metatarsus, but then there is always a notch more or less distinct dorsally at the base of this flap. The second joint of the hind tarsi presents nearly always an incision dorsally near its base in both sexes, but it is sometimes little marked.

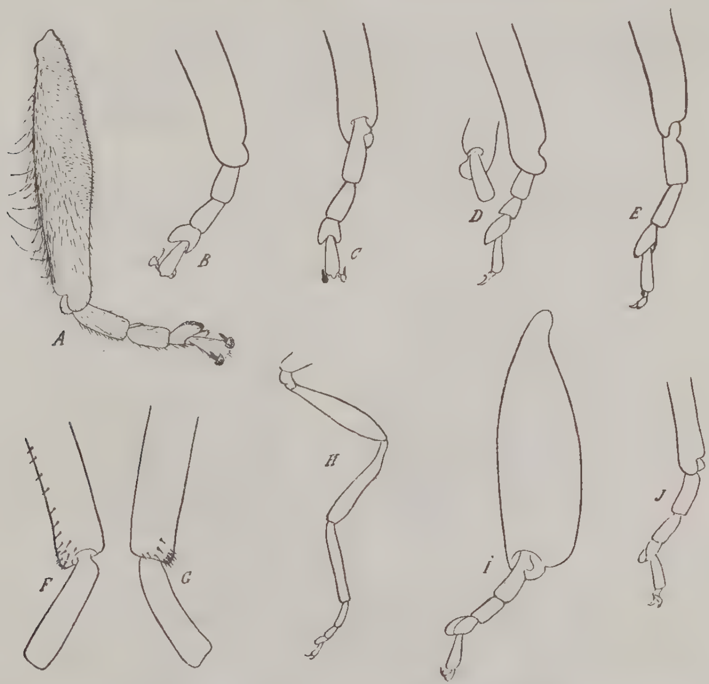

Fig. 2. Hind legs or metatarsi of (A) *Austrosimulium tasmaniense*, sp. n. ; (B, C) *A. cornutum*, sp. n. ; (D) *Simulium umbratorum*, sp. n. ; (E) *S. ornatipes*, Skuse ; (F. G. H) *S. fergusoni*, sp. n. ; (I) *A. crassipes*, sp. n. ; (J) *A. furiosum*, Skuse.

The claws of the female are either simple in the majority of cases or are provided with a large or small tooth. The claws of the male are similar all through the species ; in some positions they may appear trifid, as mentioned by several authors for American or European species, but in fact they are provided at their base outwardly with a kind of striated chitinous cushion, the upper corners of which are toothlike (fig. 3, D, E). All the tibiae carry terminal spurs, one on the front pair and two on the posterior pairs, but sometimes one of these is so reduced that the tibiae seem at first sight to have only one terminal spur.

The abdomen is composed of the usual nine segments, the basal one being expanded at the sides in the form of lamellae carrying long tufts of hairs. In the female the tergites of the 3rd to 5th or 6th segments are reduced to rather small plates more or less chitinized.

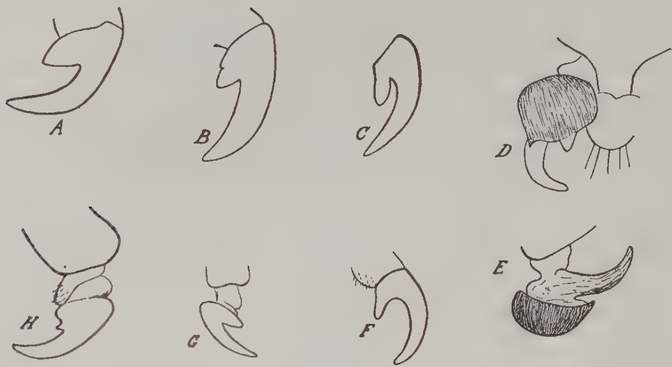

Fig. 3. Claws of (A) *Austrosimulium ungulatum*, sp. n. ♀; (B) *A. vexans*, Mik, ♀; (C) *Simulium aurantiacum*, sp. n. ♀; (D, E) *S. ornatipes*, Skuse, ♂; (F) *S. umbratorum*, sp. n. ♀; (G) *A. cornutum*, sp. n. ♀; (H) *A. terebrans*, sp. n. ♀.

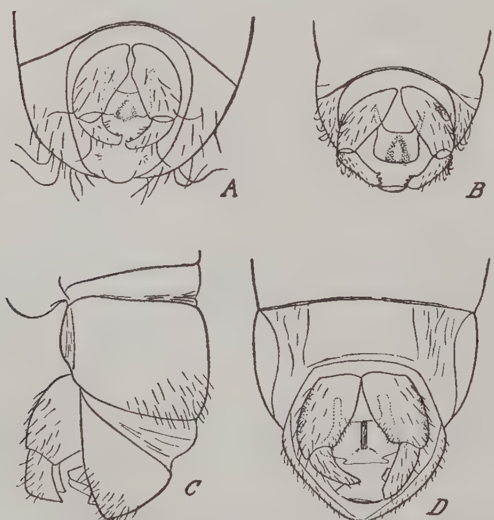

Fig. 4. Male hypopygia of (A) *Austrosimulium cornutum*, sp. n.; (B) *A. tasmaniense*, sp. n.; (C, D) *Simulium ornatipes*, Skuse.

The male genitalia are rather uniform in the shape of the side-pieces and claspers, which carry usually at their end two or three teeth, but this number does not seem to be constant in a given species, as sometimes one clasper is provided with two teeth

and the other with three ; the aedoeagus is also of rather uniform structure, but gives sometimes differentiating characters in cases where the claspers do not ; the little plates round the anus are useless for systematic purposes, as their conformation does not vary to any extent.

Larvae.

There is no essential difference between the morphology of the larvae of the Australasian SIMULIIDAE and those of the rest of the world, and, moreover, there are few characters for differentiating the Australasian species on which one can rely with certainty. Their coloration, generally of a greenish grey often variegated with blackish, does not seem constant in some species, which present sometimes melanic larvae. The black markings on the head-capsule are also rather variable in a given species ; in a well-marked specimen there is usually a median darkish line on the prefrons from the posterior border of the head to somewhat past its middle ; along

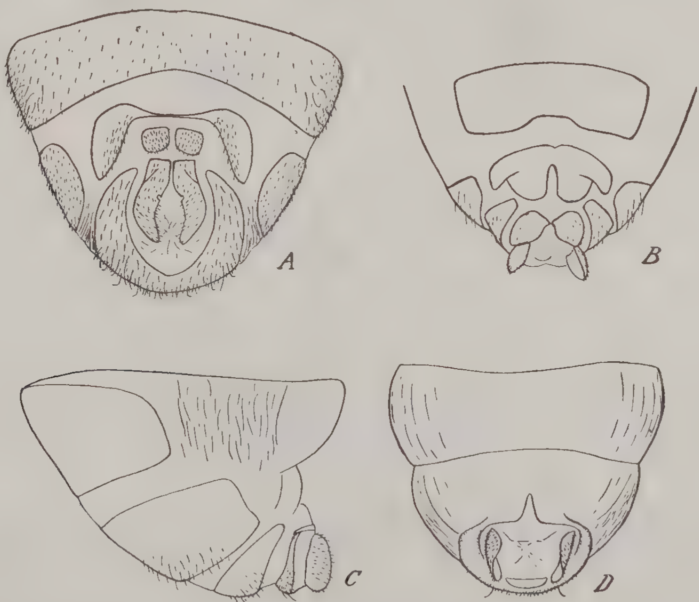

Fig. 5. Female genitalia of (A) *Simulium aurantiacum*, sp. n. ; (B) *Austrosimulium cornutum*, sp. n. ; (C. D) *S. ornatipes*, Skuse.

this line there are a few very shallow foveoles similar to those found also in the two smaller dark spots on either side of the middle of the median line ; there is also in some individuals a dark edge all round the base of the head-capsule, or else a general darkening of this capsule with the exception of the areas around the eyes, which are always formed of the two usual small black subcutaneous ocular spots.

The mouth-parts are absolutely uniform in their structure, only the disposition of the teeth of the mentum varies to some extent according to species (fig. 9), but

these teeth are always simple ; in all cases there is a larger median tooth and two large lateral ones ; the number of smaller teeth is variable, but in some groups of species the disposition is identical and the larvae cannot then be easily differentiated.

The antennae (fig. 8) are rather short ; in most cases they are about as long as the basal piece of the fan-like organ, and their relative length to that piece affords sometimes a specific character. In all known Australasian larvae the antennae are composed only of two joints ; the basal one is conico-cylindrical, whereas the terminal one is very slender, setiform, and of about the same length as the first ; the relative length of these two joints has very often a taxonomic importance. The last joint carries at its tip a diminutive sensitive cone.

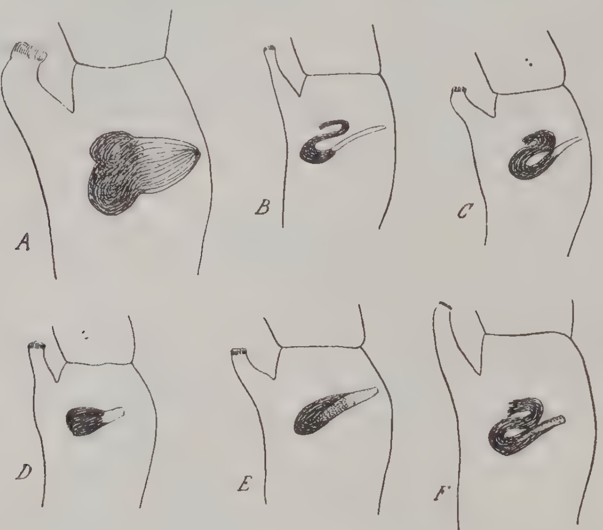

Fig. 6. Gill spots of larvae of (A) *Simulium aurantiacum*, sp. n. ; (B) *Austrosimulium simile*, sp. n. ; (C) *A. weindorferi*, sp. n. ; (D) *A. torrentium*, sp. n. ; (E) *A. tasmaniense*, sp. n. ; (F) *A. cornutum*, sp. n.

The anterior proleg and the segmentation of the body offer no clue whatever for identification. The thoracic spots of the completely mature larvae, which are formed by the pupal gills under the skin, offer, on the contrary, very often good characters of specific value. I give herewith (figs. 6, 7) the shape of this spot for each species, because in a colony one is almost always sure to find larvae in the last stage showing these spots, which afford means for a quick and sure identification, whereas the pupae are not always so readily found.

The anal gills, so far as they have been observed, are very uniform, being always composed of three subequal, simple digitations. The posterior crown of hooks is practically always composed of rows containing the same number of hooks, 12 to 15 ; in one case only this number is 35 to 40. The chitinous blackish armature (fig. 10) placed between the crown of hooks and the anus presents in some species a peculiar structure, especially on its dorsal part ; the branch it sends down on either side of the crown is sometimes straight, sometimes undulated, and ends bluntly or in a small fork ; in the case of all the New Zealand species there is a semicircular rod between

the end of each of these branches, so that here the armature makes the complete turn of the base of the crown of hooks. With one exception (*S. aurantiacum*), the two ventral papillae, placed a little above the posterior disk, are always present.

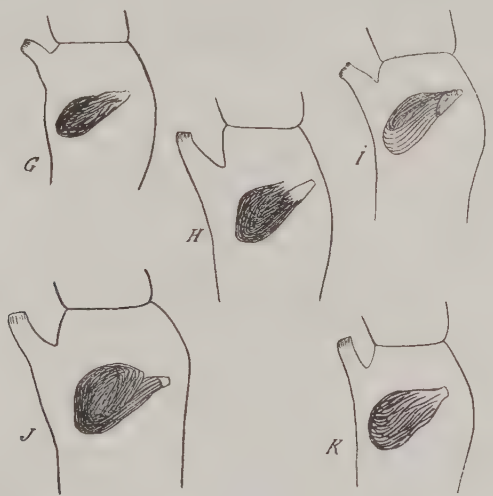

Fig. 7. Gill spots of larvae of (G) *Austrosimulium australense*, Schin. ; (H) *A. multicorne*, sp. n. ; (I) *A. tillyardi*, sp. n. ; (J) *A. longicorne*, sp. n. ; (K) *A. laticorne*, sp. n.

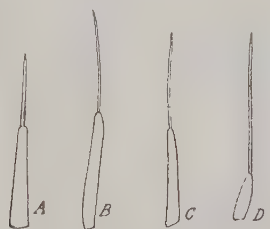

Fig. 8. Antennae of larvae of (A) *Simulium aurantiacum*, sp. n. ; (B) *Austrosimulium tasmaniense*, sp. n. ; (C) *A. weindorferi*, sp. n., ; (D) *A. australense*, Schin.

Pupae.

The shape and structure of the pupal breathing organs are very peculiar in each species as well as constant. In the species under consideration they are composed, with one exception, of a hard, chitinous, horn-like basal part more or less elongated, on which are inserted the breathing filaments ; this basal horn, which sometimes forms the most conspicuous part of the breathing organ, is either cylindrical or flattened, or spinulous at the end, or also spatulate, and when flattened the filaments may be inserted on its edge, on the whole surface or else on the tip only. The filaments vary very much in aspect according to their degree of thickness ; usually when they are thin they are also very flexible and float freely with the current ; on the contrary, when their diameter is larger they are also stiffer and their shape is not altered by the current ; in this latter case they are usually straight, but in some species they are

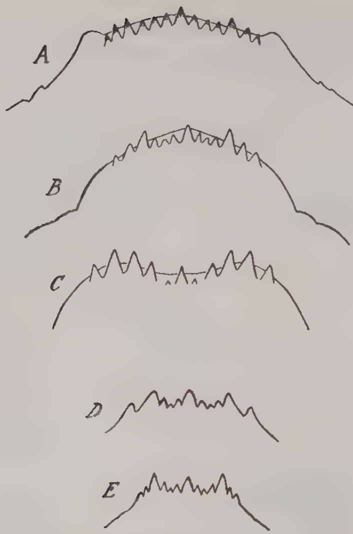

Fig. 9. Mentum of larvae of (A) *Austrosimulium tasmaniense*, sp. n. ; (B) *A. simile* ; (C) *A. cornutum*, sp. n ; (D) *Simulium aurantiacum*, sp. n. ; (E) *A. longicorne*, sp. n.

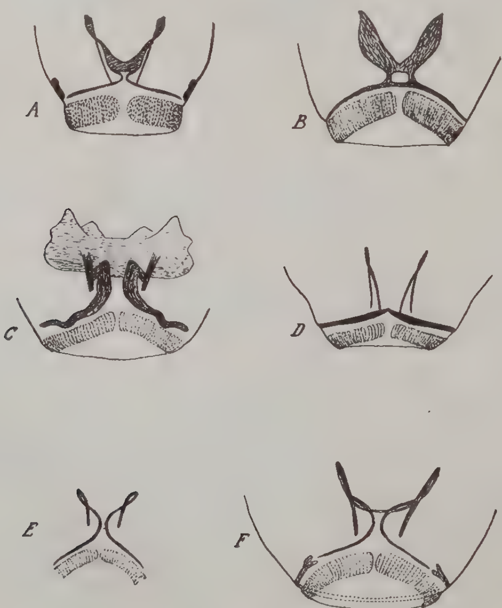

Fig. 10. Anal armature of larvae of (A) *Anstrosimulium australense*, Schin. ; (B) *Simulium aurantiacum*, sp. n. ; (C) *A. torrentium*, sp. n. ; (D) *A. tasmaniense*, sp. n. ; (E) *A. weindorferi*, sp. n. ; (F) *A. tillyardi*, sp. n.

completely curved backwards. These filaments are usually simple, in one case they are multi-branched (*S. aurantiacum*), and in some New Zealand species they are sometimes simply forked. The number of the filaments in each tuft varies greatly according to species from one dozen to about fifty, and their length in some cases is that of the pupal body, whereas in other cases it only reaches one-tenth of that length. Other features of the pupa are worthy of attention from a taxonomic point

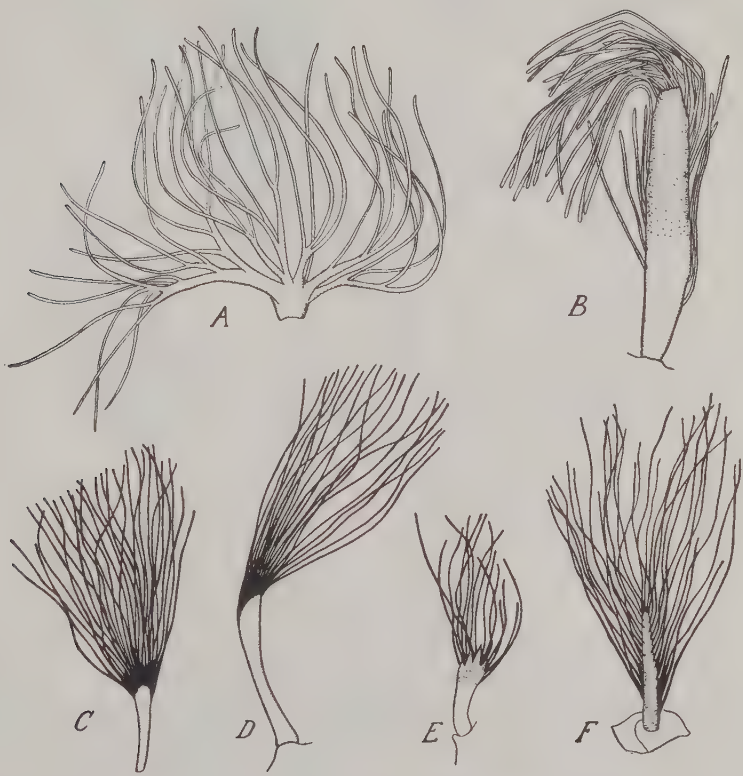

Fig. 11. Pupal gills of Australian species: (A) *Simulium aurantiacum*, sp. n.; (B) *Austrosimulium tasmaniense*, sp. n.; (C) *A. weindorferi*, sp. n.; (D) *A. simile*, sp. n.; (E) *A. torrentium*, sp. n.; (*F*) *A. cornutum*, sp. n.

of view; for instance, the integument of the dorsum of the thorax may be either smooth or granulated, and the head may present some small granulations and foveoles disposed in a peculiar way; the thorax carries usually a number of bristles either straight or hooked and sometimes strong little hooks, which serve to attach the pupa more firmly to the cocoon; also in some cases the small spines on the abdominal segments have to be taken into consideration.

Fig. 12. Pupal gills of New Zealand species: ♀(G) *Austrosimulium australense*, sp. n; (H) *A. multicorne*, sp. n.; (I) *A. tillyardi*, sp. n.; (J) *A. longicorne*, sp. n.; (K) *A. laticorne*, sp. n.

Cocoons.

In most cases the texture and shape of the cocoon afford a clue to the identity of the species. Its usual shape is that of a wall-pocket, more or less oval in shape, but sometimes it has a completely circular contour and is then much flattened ; in one case the pupa, instead of being enclosed in a cocoon, is lodged in a small excavation of the stone and is covered by a flat kind of lid with a round opening, leaving the head and a part of the thorax free. The size of the cocoon relatively to the pupa is not always the same ; the flat cocoons are much larger than the pupae, whereas the bag-shaped ones are closely adapted to the body of the pupa. In a given species there may be a certain amount of variation in the shape of the cocoon, which is due mainly to the nature of the base on which it is built ; for instance, the species with a roundish cocoon, when building it on a grass stem, have to make it much narrower, its shape being then very similar to the wall-pocket-shaped ones. In none of the Australian species known to me, with the exception of *S. aurantiacum*, is there a distinct cocoon-wall separating the ventral side of the pupa from the support ; in most cases the abdomen of the pupa is fixed to the support and to the cocoon by a few threads, but sometimes there is a beginning of a ventral wall in the inferior part of the cocoon, which forms there a pocket in which the tip of the abdomen of the pupa is lodged. The anterior opening of the cocoon is usually round, but in two instances it is provided on its rim dorsally with one or two long projections that, bending downwards, more or less protect the head or the breathing organs of the pupa. The texture of the

cocoon may be very smooth and uniform, no trace of thread whatever being visible ; it appears then as if made of a membranous matter ; this is, however, the exception, because usually some trace of the weaving is visible, and sometimes the texture of the cocoon is distinctly cellular and its outer surface rather rough. In rare instances the wall of the cocoon contains some foreign body interwoven with its silky material, like some filamentous algae or some bits of moss.

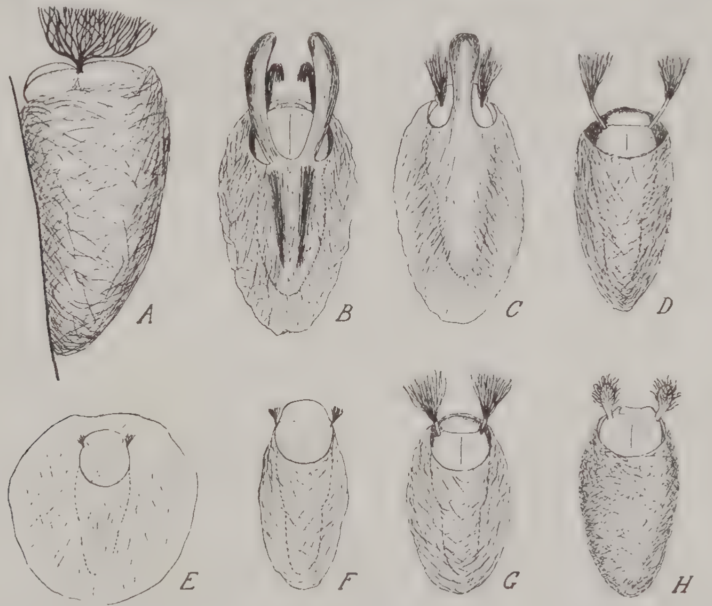

Fig. 13. Cocoons and pupae of (A) *Simulium aurantiacum*, sp. n. ; (B) *Austrosimulium tasmaniense*, sp. n. ; (C) *A. cornutum*, sp. n. ; (D) *A. simile*, sp. n. ; (E) *A. torrentium*, sp. n. ; (F) the same, narrow form ; (G) *A. weindorferi*, sp. n. ; (H) *A. laticorne*, sp. n.

Systematics.

Some time ago Dr. G. Enderlein* made a tentative effort to subdivide the old genus *Simulium* into a large number of genera. I think he failed to find the proper solution, our present knowledge of the world's species being still insufficient. Perhaps a subdivision into *Simulium* and *Prosimulium* would be advisable, if the generic character chosen for the latter be the forking of the radial sector, because the conformation of the hind tarsi as proposed by Roubaud does not afford a rational division, every degree of excision of the second joint being observable in the different species ; many would therefore remain of uncertain generic position.

As for Dr. Enderlein's other divisions, I do not propose to recognise them, because they seem to me quite unnatural, at least so far as the Australian species are concerned ; in fact, if one were to follow him they would have to be distributed in three or four of his genera, and thus some species be kept apart which are evidently very closely related. The shape of the female claws and their toothed condition are rather insecure characters, since all degrees of development of this tooth are to be found ; besides, the toothed claws occur or not in the species of *Prosimulium*, which

* Zool. Anzeig. liii, 1921, p. 43.

by their venation would otherwise form a rather compact group ; this shows that the condition of the claws must be considered as a secondary character.

All the Australian species belong to the group *Simulium*, the radial sector being simple, but they can be divided quite naturally into two subdivisions according to whether their antennae are either 11– or 10–jointed ; this character does not present any ambiguity.

For all species with 10–jointed antennae, which are the majority, I propose to erect the new genus *Austrosimulium*, the other species being left in the genus *Simulium*. The genotype of *Austrosimulium* is *S. australense*, Schin.

If Dr. Enderlein's excessive subdivisions were recognised, the species which I leave in the genus *Simulium* would have to go under his genera *Nevermannia* and *Wilhelmia*, whereas the species that I place in the new genus *Austrosimulium* would go in his genera *Cnetha*, *Nevermannia* and *Wilhelmia*.

I give hereafter tables for the adults, larvae and pupae, but they must be considered as only tentative, because certain data are still missing.

As regards the adults, the males of only 11 species out of 21 are known, and the female of one species is also unknown. On the other hand, the early stages of only nine species are known.

Table for the Adult Males.

1. Species with eleven-jointed antennae 2
   Species with ten-jointed antennae 3
2. Rather large species, mostly orange on thorax and appendages ; clasper with two teeth at the tip ... ... *S. aurantiacum*, sp. n., p. 234
   Smaller species of a velvety black coloration, the legs only with some parts orange ; clasper without teeth at the end ... *S. ornatipes*, Skuse, p. 232
3. Hind tibiae and metatarsi much swollen (fig. 2, I) *A. crassipes*, sp. n., p. 242
   Hind legs not very conspicuously swollen 4
4. Australian species 5
   New Zealand species 7
5. Distal internal lap of the hind metatarsus as wide as the metatarsus itself *A. cornutum*, sp. n., p. 243
   This lap only half as wide as the metatarsus 6
6. Third joint of the antennae nearly twice as long as wide ; larger species *A. tasmaniense*, sp. n., p. 245
   Third joint of antennae only very little longer than wide ; smaller species *A. torrentium*, sp. n., p. 247
   A. weindorferi, sp. n., p. 248
   A. simile, sp. n., p. 249
7. Pubescence of the mesonotum short, very dark bronzy, that of the rest of the body and legs also dark ... ... *A. australense*, Schin., p. 251
   Pubescence of the mesonotum longer, brassy yellow, that of the legs also lighter 8
8. Length of wing 2 mm. ... ... *A. tillyardi*, sp. n., p. 253
   A. laticorne, sp. n., p. 253
   Length of wing 2·5 mm. ... ... *A. longicorne*, sp. n., p. 254
   A. multicorne, sp. n., p. 254

Table for the Adult Females.

1. Species with eleven-jointed antennae 2
   Species with ten-jointed antennae 6
2. Large, nearly completely orange species ... *S. aurantiacum*, sp. n., p. 234
   Smaller, mostly blackish grey species 3

3. Distal end of the hind metatarsi without internal lap, and second tarsal joint not incised dorsally; claws toothless ... ... *S. fergusoni*, sp. n., p. 238
Hind metatarsi with a distal internal lap 4
4. Tibiae orange in the middle; knees and part of the tarsi also orange; pubescence of the notum of two colours, forming longitudinal stripes; claws rather straight and with a conspicuous basal tooth *S. ornatipes*, Skuse, p. 232
Legs brown or dark testaceous at most only lighter at the knees; pubescence of the thorax monochrome 5
5. Tarsal claws curved and with a conspicuous sharp tooth at the base; distal lap of hind metatarsi nearly as broad as the metatarsus; thorax partly ochraceous *S. umbratorum*, sp. n., p. 237
Tarsal claws not much curved and with a very small tooth at their base; distal lap of hind metatarsi only half as wide as the metatarsus; thorax greyish brown ... ... *S. terebrans*, sp. n., p. 237
6. Australian species 7
New Zealand species 10
7. Tarsal claws with a conspicuous tooth at base *A. cornutum*, sp. n., p. 243
Tarsal claws simple 8
8. Base of antennae orange, their last joint scarcely as long as wide *A. bancrofti*, Taylor, p. 241
Antennae completely brown, their last joint always distinctly longer than broad 9
9. Larger species, wing length 2·5 to 3 mm. ... *A. tasmaniense*, sp. n., p. 245; *A. victoriae*, Roub., p. 240; *A. furiosum*, Skuse, p. 239
Smaller species, wing length 2 to 2·5 mm. *A. torrentium*, sp. n., p. 247; *A. weindorferi*, sp. n., p. 248; *A. simile*, sp. n., p. 249
10. Tarsal claws with a conspicuous tooth at the base 11
Tarsal claws simple 12
11. Claws nearly straight, the basal tooth with a double blunt extremity; antennae completely dark ... ... *A. vexans*, Mik, p. 250
Claws curved, the tooth larger and simple; base of third antennal joint red *A. ungulatum*, sp. n., p. 250
12. Larger species, wing 2·5 to 3 mm. ... ... *A. multicorne*, sp. n., p. 254; *A. longicorne*, sp. n., p. 254
Smaller species, wing 2 to 2·5 mm. ... ... *A. australense*, Schin, p. 251; *A. tillyardi*, sp. n., p. 253; *A. laticorne*, sp. n., p. 253

Table for the Larvae.

1. No ventral papillae near the posterior crown of hooks, the row of the latter with 30–40 hooks ... ... *S. aurantiacum*, p. 234
Ventral papillae always present, the rows of the posterior crown containing 10 to 15 hooks 2
2. Antennae with the second joint about as long as the first; Australian species 3
Antennae with the second joint from $1\frac{1}{2}$ to 3 times as long as the first; New Zealand species 6
3. Indentation of the mentum as in fig. 9, C, with two large teeth on each side; gill spot showing the filaments curved in the form of an S *A. cornutum*, p. 243
Indentation of the mentum as in fig. 9, B, with only one large tooth on each side 4
4. Anal chitinous armature issuing from a large basal plate (fig. 10, A); gill spot small, brush-shaped ... ... *A. torrentium*, p. 247
Anal armature without basal plate 5
5. Anal armature as in fig. 10, D; gill spot club-shaped (fig. 6, E.) *A. tasmaniense*, p. 245

Anal armature as in fig. 10, E ; gill spot with the filaments curved in the form of an S (fig. 6, B) ... ... *A. simile*, p. 249
(fig. 6, C) *A. weindorferi*, p. 248

6. Antennae with the second joint less than twice as long as the first ... 7
The second joint twice or more than twice as long as the first 8
7. Gill spot showing the filament coiled in a spiral (fig. 7, J) *A. longicorne*, p. 254
Gill spot showing the filament simply curved (fig. 7, H) *A. multicorne*, p. 254
8. Second joint of antennae about twice as long as the first *A. laticorne*, p. 253
Second joint of antennae about three times as long as the first 9
9. Gill spot, fig. 7, G ... ... *A. australense*, p. 251
Gill spot, fig. 7, I ... ... *A. tillyardi*, p. 253

Table for the Pupae.

1. Breathing organ with filament branching several times and forming a rigid tuft ; cocoon in form of a cornet, its texture very rough *S. aurantiacum*, p. 234
Breathing organ with the filaments branching once at most 2
2. Breathing organ with a distinct basal horn on which are inserted the filaments 3
Filaments branching directly from a very short basal trunk ; cocoon wall-pocket-shaped, its texture smooth ... ... *A. longicorne*, p. 254
3. Cocoon with one or two projections inserted dorsally on the edge of the anterior opening 4
Cocoon without such projections 5
4. Cocoon with one projection ; breathing organ with 25 to 35 thin filaments forming a straight brush (fig. 12, F)... ... ... *A. cornutum*, p. 243
Cocoon with two projections ; breathing organ with about 30 filaments forming a tuft curved inwards ... ... *A. tasmaniense*, p. 245
5. Breathing organ short ; the filaments at most twice as long as the basal horn 6
Breathing organ about half as long as the pupal body or longer ; the filaments much longer than the basal horn 8
6. Horn of the breathing organ with spines at its extremity ; with about 17 thin filaments twice as long as the horn ; texture of the cocoon very smooth, its shape usually circular and very flat ... ... *A. torrentium*, p. 247
Horn without spines at the end 7
7. Basal horn flat and broad, more or less spatuliform, the filaments thin and not longer than the horn itself ; cocoon slipper-shaped *A. laticorne*, p. 253
Basal horn fusiform, its surface finely spinulous, with about forty filaments ; cocoon wall-pocket-shaped ... ... *A. australense*, p. 251
8. Basal horn long and slender, the filaments inserted at its end 9
Basal horn short, lance-shaped 10
9. Filaments about 20 in number and one-half longer than the horn ; cocoon wall-pocket-shaped... ... ... *A. simile*, p. 249
Filaments about 30 in number, more than twice as long as the basal horn ; cocoon wall-pocket-shaped ... ... *A. weindorferi*, p. 248
10. Filaments of the breathing organs thick, rigid, not exceeding fifteen in number ; cocoon slipper-shaped ... ... *A. tillyardi*, p. 253
Filaments thin, flexible, about 30 in number ; cocoon slipper-shaped
A. multicorne, p. 254

Simulium ornatipes, Skuse.

The original specimens from which the description of this species was made by Skuse are preserved in the collection of the Australian Museum in Sydney, and I have had the opportunity of studying them carefully, thanks to the kindness of Mr. A. Musgrave.

The label " type " was affixed on a pin carrying four specimens from Darling River, N.S.W., two males and two females, pasted on a slip of cardboard ; no special type being therefore indicated, I selected one male specimen on which I took the following notes to complete Skuse's description, which I will first give here.

" ♂.—Length of antennae	...	0·017 inch	...	0·42 mm.
Expanse of wings	...	0·105 by 0·050	...	2·67 by 1·27
Size of body ...	...	0·090 by 0·030	...	2·27 by 0·76
♀.—Length of antennae	...	0·017 inch	...	0·42 mm.
Expanse of wings	...	0·120 by 0·055	...	3·04 by 1·39
Size of body ...	...	0·100 by 0·035	...	2·54 by 0·88

" ♂.—Antennae short, black or dark brown, lighter towards the tip, covered with a microscopic hoary pubescence ; the joints of the scapus usually fulvous, sometimes brown or black ; 2+9-jointed ; first flagellar joint larger than the second joint of the scapus ; the next seven joints short ; terminal joints narrower, ovate. Eyes, proboscis and palpi black, face hoary, with a silvery-white pubescence. Thorax velvety-black, with two indistinct lines, the lateral margins, a large patch at the humeri, and the posterior portion, covered with shining silvery and golden pubescence ; pleurae and metanotum black ; squama behind the halteres densely fringed with long golden-yellow hairs ; scutellum covered with silvery and golden pubescence. Halteres pale fulvous or ochreous, the stem brown. Abdomen black, anterior segments sparingly covered, and the last two or three marginal posteriorly, with golden pubescence. Fore coxae yellow, the intermediate and hind pairs yellow, black at the apex, with golden-yellow or silvery pubescence ; tibiae yellow in the middle, black at the base and apex, with golden pubescence ; tarsi black, the basal half of the metatarsal and second joints in the hind-legs usually yellow. In the hind-legs the metatarsus robust, longer than the remaining joints of the tarsi. Wings longer than the entire body, hyaline, with violaceous reflections ; costa, first two longitudinal veins and cross-vein brownish, the rest pale. Venation normal.

" ♀.—Differs from the ♂ as follows :—Head and front with a silvery-white pubescence. Thorax covered with silvery white pubescence, with three short, broad, dark stripes, the intermediate one traversed by a fine median silvery or golden line. Abdomen tolerably densely covered with silvery-white pubescence.

" *Hab.* Waterloo Swamps, near Sydney (*Skuse*), in June ; near Louth, Darling River, N.S.W. (*Helms*), several specimens in Coll. Australian Museum.

" *Obs.* This is the second species of the genus described from Australia. It is at once distinguished from *S. furiosum*, Sk., by the number of joints to the antennae, the clothing of the body and the coloration of the legs."

My notes on the types are as follows :—

Male.—The antennal scape is somewhat testaceous, the flagellum dark and the tip is not lighter. The mesonotum does not present two indistinct lines but a darker median band, on account of the metallic pubescence being of two colours : dark bronzy on the disc and in front of the notum and brassy or even slightly silvery on the shoulders, the sides and the posterior part of the notum as well as on the scutellum. The bronzy pubescence seems somewhat shorter. The whole surface of the mesonotum is covered with a metallic pubescence, and does not present any glabrous dark velvety space, although the integuments of the thorax are of that colour. The yellow hairs around the scutellum are long and numerous, and the pubescence of the pre-scutellar region is not silvery and golden but light yellow only. The pubescence of the abdomen is yellow and well developed, with the exception of the last segments, where it is situated on the posterior border of the segments only, the rest of the segments carrying a few short bronzy hairs. The anterior coxae yellow, the posterior ones dark, with the apex yellow (and not the contrary as stated by Skuse) ; femora yellow with dark apex. The anterior and middle tibiae have an antemedian yellow ring, but the hind

ones are also yellow at the base much more extensively than the others, which present only a yellowish point underneath.

Female.—The mesonotal pubescence of the female is very characteristic and differs noticeably from that of the male. It is chiefly of a slightly silvery grey colour, but on the disc, which presents three long oval spots of bronzy hairs, the hairs around the edge of these spots are yellow. The median spot or short band is divided by a narrow longitudinal line of grey hairs. The grey silvery pubescence of the abdomen is everywhere uniform, rather long and somewhat denser in the middle of the dorsum of each segment. The legs are not so dark as in the male; the anterior ones present scarcely any dark markings on femora and tibiae, and on the posterior ones the yellow markings in the middle of the tibiae are more extensive.

The following morphological features are taken from a male and female from Burke and Wilcannia, N.S.W., Darling River floods, and are therefore from about the same locality as the type. They were lent to me to dissect and make microscopic mounts of them, so as to be able to study features that cannot be made out in the dry specimens. The male had the antennae a little lighter than in the type, their tips being slightly testaceous; otherwise these two specimens correspond perfectly in all points with the type and allotype.

Male.—In the 11-jointed antennae, the first joint is noticeably shorter than the second, which is about as wide as long, the third cylindrical, twice as long as the fourth, 4–10 inclusive, decreasing slightly in size, the last one olive-shaped.

Palpi with the two basal joints as broad as long, the third rather thick when seen in profile and subequal to the fourth, the fifth thin and $2\frac{1}{2}$ times as long as the fourth.

Legs: the two anterior pairs are rather slender, the tarsi of the front ones $1\frac{1}{2}$ times as long as the tibiae; the intermediate tarsi equal to their tibiae; in both pairs the metatarsi are equal in length to the other tarsal joints together. The hind tibiae are nearly as thick as the femora, and their dorsum presents a very distinct depression in the middle. The hind metatarsi (fig. 2, E) are about three-fourths the length of the tibiae and about half their width. Their distal internal lap is only half the width of the metatarsus itself; the second joint of the tarsi is rather deeply notched on the dorsum not far from the base, its length being a little less than a quarter of the metatarsus.

Hypopygium (fig. 4, C, D): the terminal joint of the claspers is laterally flattened towards its extremity, and when seen in profile shows a truncate tip; it does not carry any spines or teeth. Aedoeagus as in fig. 4, D.

Female.—The width of the frons is about one-seventh that of the head in its narrowest part, the inner border of the eyes divergent towards the vertex. Palpi as in the male, but the hind pair not so incrassate, and the tibiae only with a hint of a dorsal depression. Tarsi as in male; claws rather strongly curved and with a conspicuous tooth at the base. Genitalia as in fig. 5, C, D. The hind border of the subgenital sternite deeply notched in an acute angle; the terminal lamellae simple without notch.

Several specimens of this species have been recently collected in Sydney by Dr. E. Ferguson; they are of smaller size, the length of the wing being 2 mm.

Simulium aurantiacum, sp. n.

A relatively large species distinguished from all other Australasian representatives of the family by its rather bright orange colouring, with the exception of the abdomen, which is blackish in the males and brownish in the females.

Male.—Length of body, 2–2·5 mm.; wing, 3 mm.

Antennae dark orange, the first joint about as wide as long, the second distinctly longer; the third $1\frac{1}{2}$ times the fourth; the fourth to ninth subequal, wider than long,

the last two longer than wide, the last bluntly conical. Face greyish brown, palpi and mouth-parts brown, the first two palpal joints small and subequal, the second and third about three times as long as wide, the second distinctly thicker, the fifth $2\frac{1}{2}$ times the length of the fourth.

Thorax exceedingly arched on the dorsum, its profile being semicircular; mesonotum velvety orange darkened on the disc and more so along a median, rather broad band; seen from the front it shows a slight cinereous reflection. Pleurae orange, mesosternum brown, scutellum orange, post-scutellum orange with slight cinereous reflections in certain lights. Pubescence of thorax golden, short and adpressed, with the exception of the parts on the shoulders and before the wing space, where it is longer and somewhat erect; the pubescence of the scutellum is long, erect and mixed with a number of black hairs; a pleural tuft of hair golden. Legs mainly yellow-orange; coxae dark, with the exception of the anterior ones, which are light; the anterior legs are comparatively lighter in colour than the others, the tarsi only being brownish from the middle of the metatarsi onwards; middle legs with the femora darkened above distally, the tarsi also darkish; posterior legs with the femora, tibiae and metatarsi darkened on their distal half and chiefly on their dorsum, the rest of the tarsi dark; pubescence of the legs black and golden; it is mostly golden on the lighter parts and on their ventral face and black on the darker parts. The structure of the two anterior pairs of legs is similar, only the tarsi of the anterior ones are longer by one-half, but the relative length of the different joints remains the same. Hind legs stouter, the femora fusiform, the tibiae broadened; the metatarsi nearly as broad, more or less flattened sideways and only a little smaller than the tibiae, the extremity being produced interiorly into a long lap, which extends to about the two-thirds of the second joint, and at the level of the insertion of this last joint the metatarsi present dorsally a little notch; anterior border of the metatarsi with a regular row of small ciliae.

Wing with a slight yellowish tinge, and the membrane between *Sc* and R_1 thicker and more yellow, forming thus a kind of stigma; the tip with a slight blackish cloud; all veins orange. Venation as usual, but *Cu* moderately undulating. Halteres brownish with a somewhat lighter stem.

Abdomen velvety black, the first segment testaceous on the dorsum and the second on the sides; its pubescence golden and short, with the exception of the side-tufts of the base which are large, as usual.

Hypopygium with the terminal segment of the clasper slender, about half the length of the basal one and with two teeth at apex.

Female.—Body, 3·5 mm.; wing, 5 mm.

Eyes but narrowly separated by the frons, which is one-eleventh of the whole width of the head, its sides being parallel. Face, frons and vertex greyish with golden pubescence. Base of the antennae lighter than the flagellum; the three basal joints subequal in length; palpi as in male, but the third joint relatively longer and with its internal distal extremity somewhat produced.

The whole thorax bright orange, with the exception of the brownish metasternum; the mesonotum mat, its pubescence as in the male. Halteres yellow orange; legs of the same colour, the middle coxae, tip of posterior femora, all middle tibiae and the distal half of the posterior ones darkened; tarsi mostly brown, base of all the joints more or less yellowish, the last joint completely dark. Structure of the legs as in the male, but the hind pair relatively more slender; claws moderately curved, with a strong tooth at the base (fig. 3, C).

Abdomen brown but not velvety, basal segments with lighter part as in male; pubescence also similar.

Genitalia of the type shown in fig. 5, A; terminal lamellae with a little notch on the border a little before the middle.

Type from Mt. Wilson, Blue Mts., N.S.W., 19. xi. 1921. Allotype from Wentworth Falls, Blue Mts., 18. xi. 1921.

There is a great amount of variation in the colouring of the specimens, especially in the males, in which the mesonotum is sometimes reddish brown and the pleurae as well as the legs rather dark. The females are sometimes also much darker than the allotype, chiefly on the legs, which can be, however, completely orange ; the size varies also a great deal, the wing length in the smallest female being 3·5 mm. This species was collected by me in different localities of Australia, first in the Blue Mts. at Wentworth Falls and then on Mt. Wilson, N.S.W., in November ; the insects were captured in the proximity of waterfalls in both cases, where the pupae and larvae were found subsequently. The following year, in October, I found this species again in Victoria at Sassafras and Sherbrook Falls (Mt. Dandenong). Those obtained at Sassafras were not collected in the proximity of waterfalls, but near a creek where the flow of water was moderately swift. In Tasmania this species was met with in the National Park at the foot of the Russell Falls in December, and again in February in the Cradle Valley in a very swift-running creek running out of Crater Lake.

This species has never been observed biting by the writer or by other persons ; on Mt. Wilson it was particularly numerous, and although several hours were spent in that spot, none came flying in the proximity of the collectors. All the specimens were secured by sweeping with a net on plants ; males were obtained in the proportion of one for two females. This species was also collected in the larval or pupal stages in St. Patrick River, Burnie, Bruny Island, and on the West Coast of Tasmania on Mt. Farrell. It seems, therefore, to be well distributed all over that island.

Larva.—Length, 7·5–8 mm. ; a size that is never reached by any other Australasian species. The antennae are a little shorter than the basal piece of the fan, the second setiform joint being one-third shorter than the first. The mentum (fig. 9, D) is provided with three large teeth, the median one being separated from the lateral ones by three small teeth, the median of which is the smallest ; on the outer side of the lateral large tooth there is a smaller one placed at a lower level. The frons does not present any distinct pattern ; sometimes the whole head is pigmented, but usually only from around the eyes downwards, this dark pigmented region containing three roundish clear spots below the eyes. The colouring of the body is uniformly yellowish green without distinct markings. The gill spots (fig. 6, A) are triangular with two ventral lobes which are blackish in the mature larva, whereas the dorsal part is orange. The anal crown of hooks is rather wide and composed of exceedingly numerous rows of from 35 to 40 very small hooks placed very close to each other. The anal armature as in fig. 10, B. There are no anal papillae, but the extremity of the body is more swollen ventrally.

Pupa.—The gill tufts (fig. 11, A) contain over 40 rather rigid filaments proceeding from 6 or 7 main trunks, originating themselves on a rather wide but very short basal tube of the same nature as the filaments. The main trunks branch several times more or less regularly, the dorsal one being more developed and bearing a larger number of filaments. The dorsum of the thorax, which is much arched, carries on each side a row of very small bristles bent backwards and on the exterior side of this another pair of bristles equally small.

Cocoon (fig. 13, A).—This is in form of a cornet very narrowly applied to the body, and being rounded it is therefore usually fixed on the support by the middle of its ventral surface ; the anterior opening has a rather irregular edge and leaves the head and part of the thorax free. The texture of the cocoon is very coarse and rough and often contains some foreign matter, particularly bits of moss.

The localities where the early stages of this species have been found have been given above. It is nearly always in very swift-running water that they were observed on the stones of a fall or cascade, these stones being very often more or less covered with moss, on which the larvae fasten themselves and build their cocoons. They are,

however, found sometimes on bare stones, but in that case the cocoons are nearly always built on a broken surface of the stone. Often the cocoons are spun in a cluster of three or four together.

Simulium umbratorum, sp. n.

Female.—Head dark brown, with yellowish short pubescence and longer dark hairs, chiefly on the vertex and occiput ; antennae and palpi dark brown. Mesonotum brown, its anterior border, with exception of the middle, testaceous, as well as a part of the lateral border and an irregularly delimited area in front of the scutellum, which is also completely testaceous ; metanotum dark brown ; the remainder of the thorax is also testaceous with exception of the anepisternum and the mesosternum. Vestiture of the notum composed of short, brass-yellow hairs, also present on the scutellum ; pleural hair-tuft yellow. Legs testaceous, darker on the posterior femora and tibiae, their vestiture yellow but for a few longer dark hairs. Halteres with orange stem and yellowish white knob. Abdomen mat brown, the basal segment testaceous, with the long lateral hair-tufts yellow ; the rest of the abdomen with moderately dense, short, erect, yellow pubescence.

Antennae (fig. 1, C) with eleven joints ; the first one short, the second $1\frac{1}{2}$ times as long and very little longer than wide, the third a little shorter than wide, the fourth half as long as wide, the following ones gradually increasing in length, the tenth being as long as wide, the last one conical, twice as long as wide ; the whole antenna about as long as the head is wide.

Palpi of the usual structure, the three last joints subequal.

Frons one-quarter the width of the head, with its sides divergent backwards and with a very sharp middle furrow.

Anterior legs not incrassate in any of their parts ; in the front ones the tarsi are about one and a half times as long as the tibiae. Hind legs stouter ; the tibiae moderately wide ; the metatarsi not quite as wide and provided with an internal terminal lap as wide as the metatarsus itself but narrowed at its base dorsally so that the metatarsi present there a noticeable dorsal notch (fig. 2, D), the anterior border of the metatarsi carries a row of about ten very small bristles. Second hind tarsal joint not distinctly incised at its base dorsally. The claws rather strongly curved and provided with a conspicuous basal tooth pointing outwards (fig. 3, F).

Wings as usual, but with *Cu* practically straight.

Genitalia of the type shown in fig. 5, B.

Length of wing, 3 mm.

Type in the Cawthron Institute and three paratypes in the writer's collection from Fern Tree Gully, Mt. Dandenong, Victoria, 25. x. 1921 ; obtained by sweeping plants with the net ; not observed biting.

This species is readily distinguished from the other Australian species by the vein *Cu*, which is nearly straight, its testaceous legs and sides of thorax, and by the shape of the tooth of the tarsal claws. The early stages are unknown.

Simulium terebrans, sp. n.

A darkish medium-sized species similar to *A. furiosum*, but differing at first sight by the dark halteres.

Female.—Length of wing, 2·3 mm. Face and frons grey with yellow pubescence ; vertex and occiput also covered with the same sort of hairs. Vertex only with a few long black hairs. Antennae and palpi completely dark brown. Shoulders slightly reddish, mesonotum in certain positions slightly shining under its short pubescence ;

hairs and anterior part of scutellum yellowish, on its posterior border black, long and dark; the post-scutellum seen from behind has a slight silvery gloss; anepisternum with greyish reflection, the rest of the pleurae and sternum blackish brown, with some reddish under the base of the wing. Legs completely blackish, no trace of yellow underneath, their pubescence light yellowish with only a few blackish longer dorsal hairs. Wings as usual; halteres with dark brown knob and stem somewhat testaceous. Abdomen mat brown, strongly reddish on the sides owing to the blood absorbed by the specimen; the small tergal plate of segments 2–5 mat brown like the following segments and bare; the last part of the abdomen with short adpressed yellowish pubescence and longer darker hairs; lateral tuft of the three segments yellow.

Antennae composed of 11 joints; the first small, the second twice as long and about as long as wide, the third a third shorter, the fourth twice as wide as long, the following ones gradually but slightly increasing in size, the tenth being only a little wider than long, and the last conical, about half as wide as long.

Palpi of the usual type, the first two joints very small, the last three subequal, the second incrassate, but more or less flattened laterally, the last slightly club-shaped. Frons rather narrow, equal to one-sixth of the width of the head with a slight median groove.

Wing venation as usual.

Legs: the front ones distinctly longer than the middle ones; hind metatarsi about as broad as the tibiae and a little shorter only; the distal lap about half the width of the metatarsus itself and as long as wide; second joint deeply incised dorsally near its base. Claws with a very small tooth at the base (fig. 3, H).

Genitalia as in all the allied species, of the type shown in fig. 5, B.

Male unknown.

Type, a female from Sassafras, Victoria, 22. x. 1922; caught while biting the writer's hand; the irritation caused by its bite was but small.

Four specimens (females) from Canoblas, New South Wales, 11. x. 1916; in the collection of the Board of Health, Sydney. They correspond very well with the Victorian specimen, their size being only somewhat larger; wing, 3·2–3·4 mm. The antennae are very slightly longer, otherwise they agree with the type in its specially characteristic features, *i.e.*, the small tooth of the claws, the narrow frons and black halteres.

Simulium fergusoni, sp. n.

A large, blackish-grey species distinguished at first sight by the absence of the distal internal lap on the metatarsi.

Female.—Wing length, 3·5 mm. Completely greyish black, including the legs, with the exception of the halteres, which are testaceous; pleurae uniformly greyish. Face with small, dull yellowish hairs, vertex besides with a few black longer ones; the post-ocular vestiture dense and also yellowish, with a few black hairs intermingled. Pubescence of the mesonotum of a dull yellow colour, short, rather dense, and extending also on the scutellum, where there are besides some longer erect black hairs, especially on the margin. Pubescence of the legs completely yellow, also the longer dorsal hairs of the femora. Lateral basal tufts of the abdomen moderately developed, and yellowish as well as the rest of the vestiture of the abdomen; that of the tergal plates small and scanty.

Frons with divergent sides, about one-fifth of the total width of the head and with a distinct median groove. Antennae with 11 joints; the first half the length of the second, which is as long as wide; the three following decrease in length, so that the

fifth is only half as long as wide ; the sixth and following ones gradually increasing in size, the tenth being as long as wide ; the last conical, not quite $1\frac{1}{2}$ times as long as wide.

Palpi about as long as the antennae ; the third joint is distinctly the longest and is noticeably produced at its distal end internally ; the fourth is half the size of the fifth, which is a little shorter than the third.

Wing venation as usual, but the curve of *Cu* somewhat more pronounced (for a female) than in other species.

Legs : the front tarsi not broader than the middle ones but slightly shorter (50 : 57). The hind legs only moderately incrassate, the dorsum of the hind tibiae slightly undulated (fig. 2, H), the hind metatarsi moderately wide, about half the greatest width of the tibiae (5 : 9) and little flattened ; there is no distinct internal distal lap (fig. 2, F, G) ; the anterior border of the external side of the metatarsus carries a row of little spinules, which are also present on the internal side but only at the tip of the metatarsus, where they are more numerous ventrally ; second hind tarsal joint not incised dorsally, rather elongated, about one-third of the metatarsus ; claws simple, a little swollen at base but without any tooth.

Genitalia as usual, of the type shown in fig. 5, B.

Male unknown.

Type and 11 paratypes (females) from Bumberry, N.S.W., 1. x. 1916. All these specimens carried the indication " biting man." They were taken in company with *A. bancrofti*, Taylor.

This species is easily distinguished from all the others by the absence of the lap on the metatarsi, the short fourth palpal joint, the small last antennal joint, and by the second hind tarsal joints not being incised dorsally.

Austrosimulium furiosum, Skuse.

Skuse's description, which is accurate, runs as follows :—

" ♀. Length of antennae, 0·42 mm. ; expanse of wings, 2·39+1·13 ; size of body, 2·02+0·62.

" Antennae short, black, densely covered with a microscopic hoary pubescence ; 2+8-jointed, second joint of the scapus twice the length of the first, first flagellar joint about as large as the second joint of the scapus, three following short, next three large, terminal joint elongate-ovate (fig. 1 B). Head, hypostoma, and palpi black, with a minute yellowish pubescence, very dense on the latter ; joints of the palpi as follows : First joint small, second twice the length of the first, stout, elongate-ovate, third somewhat shorter than the second, more slender, claviform, a little emarginate on the inner side near the apex, fourth joint somewhat longer than the second, slender, sub-cylindrical, a little dilated towards the apex. Eyes deep black. Thorax black, opaque, indistinctly divided by three striae, beginning below the anterior margin and terminating before the scutellum ; rather densely covered, more especially anteriorly, with a microscopic pale yellow pubescence ; pleurae, pectus, scutellum, and metathorax black, opaque. Halteres pallid, the base of the stalk black, with a minute pale pubescence. Abdomen black, opaque, the third to the seventh segment with a square median patch of intense black, densely clothed with short hairs. Legs brownish-black, with a pale yellow pubescence, interspersed with longer hairs ; genua yellow ; metatarsus of the hind-legs nearly twice the length of the four following tarsal joints, and longer than the tibiae of the intermediate—or fore-legs. Wings longer than the entire body, hyaline, brownish at the root ; costal vein black, auxiliary and first two longitudinal veins sordid yellowish-brown ; third, fourth, fifth and sixth longitudinal veins pale. First and second longitudinal combining with the costa before the tip

of the fourth longitudinal vein ; tip of the costal vein nearer the apex of the wing than the tip of the anterior branch of the fork of the third longitudinal ; marginal cross-vein about as long as the petiole of the second sub-marginal cell. Wing-fold between the third and fourth longitudinal veins furcate before joining the posterior border ; wing-fold between the fifth and sixth longitudinal veins nearer the former, bent abruptly forward at its tip, and joining the wing-border very close to the tip of the fifth longitudinal vein ; sixth longitudinal vein complete.

" *Hab.* Gosford and Berowra (Skuse). August and September."

The type of this species was examined by me in the collection of the Macleay Museum in Sydney, and I noted that the description applies very well to it, so far as one is able to judge from its rather bad state of preservation, the vestiture of the body having completely disappeared.

The claws are not toothed ; the hind metatarsi are a little shorter than the tibiae and are provided at their apical inner end with a small lap having only about half the width of the metatarsus itself ; the pubescence of the legs is yellowish. The three other paratypes (two of them being paratopotypes) also ♀♀, correspond well with the type ; one of them has the vestiture of the metanotum in good condition ; it is uniformly brass-coloured. There is a small ferruginous part at the extreme base of the tibiae, so that the knee may be said to be narrowly ferruginous.

One of the paratopotypes was dissected and mounted. Its frons is equal to a quarter of the width of the head ; the antennae 10-jointed ; the first joint is equal to half the second, which is about as long as wide, the third a little shorter, and the fourth a little shorter still, all the remainder being as long as wide. Palpi with the last joint only a quarter longer than the third, the fourth half as long as the third.

Venation as usual ; legs also, the lap of the hind metatarsi being half the width of these latter and reaching a little beyond the dorsal incision of the second joint ; the claws are simple.

The male is unknown.

In Sassafras, Victoria, I collected one female specimen (22. x 1922) which does not seem to differ from *S. furiosum*, but it cannot with certainty be referred to this species, the locality being so distant from that of the type, and the species of *Austrosimulium* being so very much alike in the adult stage.

Austrosimulium victoriae, Roub.

Simulium victoriae, Roubaud, Bull. Mus. Hist. Nat. Paris, 1906, No. 7, p. 521.

This species was described by Roubaud from numerous female specimens in the collection of the British Museum, coming from an uncertain locality in Victoria. The description, although somewhat extensive, is too vague and does not mention some of the points of chief importance, such as the relative width of the frons and the relative length of the antennal and palpal joints ; it could consequently apply to most of the dark Australian species. As the number of joints in the antennae is also not mentioned, it is uncertain if it belongs to the genus *Simulium* or to *Austrosimulium*, but as Roubaud considers it to be the nearest species to *A. vexans*, Mik, which belongs to the latter genus, I think *A. victoriae* has also to be considered as an *Austrosimulium*.*

* The type and other specimens of *S. victoriae*, Roub., in the British Museum have 10-segmented antennae, and therefore the species belongs to *Austrosimulium*. It is probably distinct from *A. tasmaniense*, because the terminal lap of the first hind tarsal segment is more than half as broad as the segment itself, which bears a few longish hairs dorsally ; there are also similar and more numerous hairs on the last four segments of the hind tarsi.

The species identified by Roubaud from Victoria as *S. vexans*, Mik, is not the same as the New Zealand form so determined in this paper. It is a true *Simulium*, apparently the same as *S. umbratorum*. Besides the specimens examined by Roubaud, others have recently been received from Beaconsfield, Victoria, 6.xi.1923 (*G. F. Hill*).—F. W. Edwards.

One specimen of this latter genus collected in Morisson, Victoria, in the collection of Dr. Ferguson, may be referred to this species, although without making a dissection it is impossible to say if it really differs from *A. furiosum*, *A. cornutum*, etc.

Roubaud's description runs as follows :—

" Femelle.—Entièrement noir terne, à pubescence d'un gris poussièreux. Sur le thorax une pilosité jaune pâle, clairsemée. Balanciers blanchâtres. Ailes à nervures noirâtres, toutes bien marquées.

" Pattes en entier brunâtres, plus claires que le thorax, fortement villeuses. Tibias et tarses antérieurs noirs, ces derniers grêles, non dilatés. Métatarses postérieurs aplatis, à bord antérieur légèrement arqué, inerme, sans épines saillantes ; le bord postérieur est fortement cilié ; l'expansion terminale forte atteignant l'échancrure du premier tarsien qui est nettement allongé et sensiblement linéaire. Griffes courtes et simples. Abdomen uniformément brun noirâtre, plus clair au ventre, revêtu de poils grisâtres ou foncès.

" Cette espèce, en raison de la longueur du premier article de ses tarses postérieurs, de ses nervures bien marquées aux ailes, de toute son apparence extérieure, parait appartenir au premier abord au sous-genre *Prosimulium* tel que nous l'avons défini.

" Voisine de *S. vexans*, Mik, elle s'en distingue par sa teinte beaucoup plus sombre, ses métatarses postérieurs inermes et ses griffes simples."

Austrosimulium bancrofti, Tayl.

Simulium bancrofti, Taylor, The Aust. Zool., i, 1918, p. 168.

Taylor's description runs as follows :—

" Female :—*Head* black with grey tomentum ; front with a well-defined median groove ; palpi black with black and pale pubescence, first joint pale, apex of second narrower than base, third strongly emarginate on the inner side towards the apex, fourth long, thin, cylindrical ; antennae nine-jointed, first two brownish, first shorter than second, latter about the length of the third, third to the apex black, third broadest and about twice the length of fourth ; proboscis black, apex with short, stout pubescence ; eyes coppery.

" *Thorax* : Black, tomentum grey, pubescence pale ; pleurae black with grey tomentum.

" *Abdomen* : First segment deep black, two to six deep black with median apical ash-grey spots, small on the second and increasing in size to the sixth, which is ash-coloured, except for a narrow basal and lateral margin of deep black, seventh ash-grey, with a narrow lateral deep black border, eighth ash-coloured, third to fifth also with apices of sides ash-coloured, pubescence black, pale on the pale areas ; venter grey with grey pubescence. Halteres pale creamy.

" *Legs* : Dark yellowish-brown, tibiae dark brown above, anterior tarsi black, except base of first yellowish-brown, mid and posterior tarsi yellowish-brown, second to fourth with their apices dusky, first posterior tarsi dusky beneath ; pubescence pale ; apex of tibiae with a stout spine ; apex of first posterior tarsi produced into a terminal expansion overlapping the second tarsals beneath.

" *Wings* : Clear, pale yellowish at the roots ; costa, auxiliary and first long veins paler than roots, remaining veins almost indistinguishable from wing membrane.

" Length, 2 mm. ; length of wing, 2 mm."

I have seen a good series of female specimens in the collection of Dr. Ferguson, some of them being paratopotypes and the others coming from Dawson River and Bumberry, N.S.W., 1. x. 1916.

They correspond well with the description so far as the coloration is concerned, but the account of some of the morphological features needs to be altered and supplemented as follow :—

The width of the frons is a little over a quarter of that of the whole head (12 : 40) ; the antennae (fig. 1, B) are rather short, a little less than three-quarters of the width of the head (27 : 40). They are composed of ten joints, but the last joint, which is small, is sometimes partly fused with the preceding one, so that the antennae may appear at first sight nine-jointed ; this explains Taylor's error on that point. The first three joints cyathiform, the first very small, the third nearly twice as broad and twice as long as the first, the second intermediate in size ; fourth joint not quite so wide as the third and very short, about 3 times as wide as long, the following joints gradually diminishing in width but increasing in length, so that the ninth is about as long as wide, the last conical, subequal to the preceding one.

Palpi five-jointed ; the first two joints small, as usual ; the third and fourth subequal to each other, the third fusiform but somewhat thinner at its distal end, the fourth with a truncate extremity (not emarginate) ; the fifth thin, cylindrical, $1\frac{1}{2}$ times as long as the fourth.

Legs : Front tarsi slightly dilated, without spinules ; middle tarsi with the first three joints carrying some spinules underneath, especially towards their extremity. Hind metatarsi about as long as the tibiae but only half as wide ; they do not carry setae on their anterior edge but are provided with an internal distal lap of only half their width ; this lap is rather short, as it does not reach the level of the dorsal incision of the second tarsal joint, which carries a few spinules on its plantar face. The claws do not present any tooth at their base and are little curved.

Genitalia of the usual type shown in fig. 5, B.

The wing venation as usual, only *Cu* with its bend placed more towards its extremity and more marked.

Austrosimulium crassipes, sp. n.

Male.—Face brown, with a few yellowish hairs and some longer black ones ; antennae and palpi black ; occiput very moderately pubescent. Mesonotum velvety black, with yellow-golden adpressed pubescence (longer anteriorly) on the sides and in front of the scutellum, where there are also some black erect longer hairs like those on the border of the scutellum, which carries besides a few small yellowish hairs. Space in front of the scutellum and metanotum with cinereous reflections when seen from behind ; anepisternum with a rather strong silvery gloss ; the rest of the pleurae and sternum brown, with only a slight greyish reflection in certain positions.

Legs completely dark, with mostly yellowish pubescence, the hairs on the dorsal part of the femora being blackish. Halteres with the stem and base of knob blackish, the distal part dark orange. Abdomen velvety black, with dull yellow adpressed and moderately long pubescence ; side-tufts of basal segment long and dark yellowish.

Antennae ten-jointed ; the first joint shorter than the second, which is about as wide as long ; the third is of the same length but somewhat more slender ; the following ones are subequal to each other and about as long as wide ; the last conical, elongated, and twice as long as wide.

Palpi with the first two joints small as usual, the third and fourth subequal, the third incrassate, the fifth thin and twice as long as the fourth.

Wing venation as usual.

Legs : anterior tarsi thin, the front ones $1\frac{1}{2}$ times as long as their tibiae, the middle ones subequal ; hind tibiae dilated and as broad as the femora ; hind metatarsi very

much swollen (fig. 3, I), a little wider than the tibiae and somewhat shorter ; they are provided at their internal distal end with a short lap about as wide as a third of the metatarsus itself ; second tarsal joint deeply incised dorsally near its base.

Hypopygium : claspers about half the length of the basal pieces and provided at the end with two small triangular teeth ; the aedoeagus ending in a process projecting rather conspicuously downwards between the two basal pieces of the claspers.

Type in the Cawthron Institute ; a single ♂ from Sassafras, Victoria, 22. x. 1922.

This species is distinguished at once by the very much incrassated hind tibiae and metatarsi. It is not impossible that this specimen may have to be referred to *A. furiosum*, Skuse, the male of which is not known. However, this latter species is not very well characterized and was found in a very far distant locality in New South Wales ; besides, there is some difference of coloration in the halteres, the knob of which is completely orange in *A. furiosum*, and also the knees are completely black. It is therefore safer to consider this male as belonging to a distinct species ; investigations at Gosford, N.S.W., the original locality of *A. furiosum*, will show sooner or later if this view is justified.

Austrosimulium cornutum, sp. n.

A middle-sized species easily distinguished by the toothed claws in the female and the relatively long second joint of the antennae in the male, and also in both sexes by the terminal lap of the hind metatarsi, which is of the same width as the metatarsus itself.

Male.—Face, antennae and palpi black, with dark pubescence, the row of hairs between the eyes and those on the vertex being rather long and black. Mesonotum velvety black, with golden, rather long but adpressed vestiture ; the region in front of the scutellum with slight cinereous reflections in certain lights. Scutellum velvety black, with only black erect hairs. Sides of the thorax brown, with greyish reflections in most positions and much stronger on the anepisternum ; pleural hair-tufts blackish. Halteres with a brown stem and bright orange knob. Legs black, with extreme base of the tibiae orange, and pubescence yellowish, especially on the ventral side of the femora and tibiae, dark on their dorsal and posterior sides, but the anterior tibiae almost completely covered with yellowish pubescence. Abdomen velvety black, with dark hair, also the large basal side-tufts composed of dark hairs.

Antennae with 10 joints ; the first longer than wide, subequal to the third, the second one-third longer, the fourth somewhat wider than long, the following ones gradually but slightly increasing in size, the last conical, rather elongated but not quite twice as long as the preceding one (5 : 3).

Palpi with the first two joints small, subequal, the third swollen subequal to the fourth, the fifth two-thirds longer than the fourth.

Legs : anterior tarsi not thickened, but one-half longer than the tibiae, the metatarsi equal to the four other joints together. Mid-femora and tibiae equal to the anterior ones, but the tarsi shorter, equal to the tibiae, the metatarsi equal to the four other joints. Hind femora and tibiae moderately swollen, subequal in width ; metatarsi flattened, two-thirds the width of the tibiae and nearly as long (32 : 36), produced at their internal distal end in a rounded lap nearly as wide as the metatarsus (fig. 2, B, C), which presents dorsally at the base of the lap a very slight notch ; the lap reaches downwards well over the deep basal incision of the second joint ; the last four joints about equal to half the metatarsus ; claws as usual, with the basal swollen pad.

Wing as usual ; *Cu* well curved.

Hypopygium (fig. 4, A): claspers ending in two small triangular teeth; aedoeagus shaped like a violin-bridge, with a median triangular pad, densely but finely hairy.

Length of wing, 2·5 mm.

Female.—Face and frons grey, with yellowish adpressed short pubescence and a few longer black hairs, which are more numerous on the vertex; the occiput also covered with short yellow hairs. Mesonotum black, densely covered with a dull golden-yellow adpressed pubescence, the hollow before the scutellum slightly greyish; scutellum black, with black erect hairs, the yellow pubescence localised only at its very base. Side of thorax brown with grey pruinosity, especially on the anepisternum but extending towards the base of the hind coxae. Pleural hair-tuft blackish. Legs as in the male, black with the extreme base of the tibiae orange, but the pubescence nearly all yellow, only the longer dorsal hairs blackish. Halteres with brown stem and white knob. Abdomen dull black, the tergal plates small and not very distinct from the rest of the integument; pubescence formed of sparse short yellow hairs and longer black ones, which are more conspicuous and longer towards the end of the abdomen; the large basal side-tufts yellowish.

Frons equal to one-fifth of the width of the head, its sides parallel in the lower half; antennae as in the male, but the second and last joints relatively a little shorter Palpal joints in the same proportion as in the male, the last joints only being somewhat longer, the third joint rather flattened laterally. Legs also as in the male, but the hind ones somewhat more slender. The hind metatarsi relatively a little shorter compared with the tibiae (34 : 40), but the conformation of the terminal lap and of the second joint identical. The disproportion between the anterior and middle tarsi not so great; claws strongly curved, bifid, or rather with a very large basal tooth half the length of the claw itself (see fig. 3, G). Wing as usual: *Cu* less curved than in the male. Genitalia of the usual type, as in fig. 5, B.

Length of wing, 3 mm.

Larva.—Length 7 mm., when full grown, and distinguished by the disposition of the teeth of the mentum, which is shown in fig. 9, C. The rest of the mouth-parts do not seem to differ from those of the other species. Antennae two-jointed; the first joint elongated, about six times as long as broad; the second setiform, one-half longer than the first; the whole antennae only a third longer than the basal piece of the fan. The thoracic spots formed by the nymphal gills seen through the skin are more or less rounded as a whole, but show the breathing filaments curved in the shape of an S (fig. 6, F). The rectal gills have not been observed. The markings of the fronto-clypeus are very inconspicuous and rather indefinite; they are composed of a faint median line broader nearer the posterior margin and extending forward to the level of the base of the antennae; on each side of the middle of this line is a small blackish spot. The dark markings of the body are indefinite in shape.

Pupa.—Characterised by its breathing organ (fig. 11, F), which is composed of a rather long hard chitinous brown horn, tapering towards the end and carrying from 25 to 35 thin nearly straight filaments, which are on an average twice as long as the basal horn and inserted on it from a little above its base to its end. The nymphal integuments do not present any granulation on the head and thorax; on the notum of the thorax are to be found two rows of four bristles, the anterior pair very thin, straight and inconspicuous, the three others stouter, longer, not tapering towards the end but curved into a hook. Exteriorly to the anterior small bristles there is on each side a stouter and larger straight one.

Cocoon.—Rather large (fig. 13, C), about 4 mm. long, its outline oval, the middle of the border of the anterior opening provided with a long projection curving downwards so as to protect the head of the nymph; this projection is somewhat wider at its end, which is rounded.

Type from Sassafras, Victoria, 22.x.1922. Paratypes from :—

New South Wales : Wentworth Falls, Blue Mts., 16.xi.22, 1 ♀. Victoria : Sassafras, 27.x.22, 6 ♂ 6 ♀. Tasmania : Burnie (N.W.), 26.x.22, 4 ♀ ; St. Patrick River (N.), 4.xi.22, 1 ♂ 1 ♀, reared from larvae ; National Park (C.), 15.xii.22, 2 ♀ ; King River (W.), 1.ii.23, 1 ♀ ; Strahan (W.), 5.ii.23, 9 ♀.

The larva and nymph have also been found in the following Tasmanian localities : St. Patrick River, National Park, Fern Tree (Mt. Wellington), Cradle Mt., Eagle-Hawk Neck (Tasman Peninsula).

This species has not been observed biting. I found it for the first time in sweeping plants with a net at Sassafras, Victoria, along a gully at the end of October, and later on in different parts of Tasmania, but no specimens were ever observed flying around me. In the beginning of the season the males were apparently as numerous as the females, but later, in Tasmania, I did not find any except one obtained by rearing. The larvae were sometimes very difficult to detect, and on some occasions impossible to find, although the flies were numerous, as in Sassafras and Strahan, where no trace of them could be found after several hours of search in the stream. The pupae were found fastened only on stones, with one exception, where they were observed on a bit of reed dipping into the current. On several occasions they were in company with those of other species such as *A. torrentium*, *A. tasmaniense*, *A. weindorferi* and *A. simile*, spp. n., but were always rather scattered, never in colonies ; they seem to require a swifter current of water than the other Australian species, except *S. aurantiacum*, sp. n.

Austrosimulium tasmaniense, sp. n.

Male.—Face, antennae and palpi dull black, with dark hairs ; occiput with a very long and dark pubescence. Mesonotum velvety black, with brown, adpressed and rather long pubescence ; prescutellar depression with very slight greyish reflection, carrying, as well as the scutellum, only long erect black hairs. Pleurae dark brown with the exception of the anepisternum, which presents a rather intense silvery pruinosity ; the region below the base of the wing is somewhat ferruginous ; the pleural tuft of hairs is black. Halteres blackish brown, only the extremity of the knob slightly orange dorsally. Legs completely dark as well as the pubescence. Abdomen velvety black, the pubescence dark brown, also the basal side-tufts.

Antennae ten-jointed (fig. 1, A) ; the first joint smaller by one-third than the second, which is about as long as wide ; third joint relatively long, equal to the first two together ; the following joints as long as wide ; the last conical, $1\frac{1}{2}$ times as long as wide.

Palpi with the first and second joint small, as usual, the third and fourth subequal, the last longer than the fourth (8 : 6).

Venation as usual.

Anterior legs not dilated in any of their parts ; hind legs rather stout, the metatarsi (fig. 2, A) a little smaller than the tibiae and without setae or bristles on the anterior edge ; their interior terminal lap is only half as wide as the metatarsus ; second tarsal joint rather deeply incised dorsally near its base.

Hypopygium : claspers provided with three teeth at their extremity, aedoeagus in the form of a violin bridge (fig. 4, B).

Length of body, 2·5 mm. ; wing, 2·5 mm.

Female.—Head grey, with short yellowish pubescence and a few longer dark hairs. Antennae and palpi black, the latter with dark pubescence. Mesonotum mat, blackish grey, and presenting three rather indistinct darker bands when seen from behind ; it is covered with a very short, adpressed, moderately dense, pale yellow pubescence,

which extends on the middle of the prescutellar depression and the base of the scutellum; the rest of both these parts carrying long erect black hair. Pleurae blackish grey, the anepisternum being more greyish than the rest but not so light by far as in the male; the region under the wing's base ferruginous; pleural tuft of hairs black. Legs completely black, with short yellowish pubescence and a few longer black hairs dorsally. Halteres with the stem blackish and the knob whitish. Abdomen dull blackish grey, the tergal plates of segment 3–6 relatively small, with very short and scanty yellowish pubescence; some longer dark hairs on the sides and tip of the abdomen, the basal side-tufts long and yellowish.

Antennae with the first joint shorter than the second joint, which is subequal to the third; the fourth distinctly wider than long, but the following joints gradually narrower, so that the ninth is as long as wide; last joint conical, twice as long as wide. Palpi as in male.

Width of the frons a little less than a quarter of the whole width of the head and with a distinct median furrow. Legs as in the male; the claws simple.

Genitalia of the type shown in fig. 5, B.

Size very little larger than in the male.

Type from Cradle Valley, Tasmania, bred from pupa 13.i.1923, in the collection of the Cawthron Institute; allotype from the same locality. This species was also found in Tasmania in the following localities: St. Patrick River, end of October and beginning of November, both sexes at the same time; Mt. Wellington in November, females only; Geeveston, 7th December, females only; Hartz Mts. 3,000 ft., 9th December, females only; Mt. Field, 3,500 ft., 20th–21st December, females only.

The larvae and pupae were observed besides in the Brown River, Hobart, in December, and in Russell Fall, National Park, in December. This species seems thus to be spread all over Tasmania, with exception of the West Coast and the North-West. So far it has not been found on the Australian mainland.

Several times I have caught female specimens of this species hovering round my face or hands, but without making any attempt to bite.

Among the bred male specimens I found several anomalies which are worth being recorded here. In one case one side of the hypopygium was normal, whereas the other was composed of a stunted clasper and a small female lamella, all other parts of the body seeming normal. Two other specimens presented an abnormal segmentation of the antennae, several joints being irregularly fused together, so that one antenna was composed sometimes of six irregularly-shaped joints and the other of eight, the antennae retaining, however, their normal length. The hypopygium of another specimen had one branch of the claspers with two terminal teeth and the other with three.

Larva.—Length 5–6 mm. Antennae rather short (fig. 8, B), equal in length to the basal piece of the mouth-fan, the second joint very little shorter than the first. Indentation of mentum as in fig. 9 A; the three teeth on either side of the middle one do not differ so much in size from the latter and the two larger external ones. The markings of the frons are rather indistinct and offer no clue for a certain identification. Gill spot (fig. 6, E) transverse, elongated, the filaments folded upwards closely against the basal horn of the breathing organ. The rows of the anal crown contain from 12 to 15 hooks. Black anal armature as represented in fig. 10, C.

Pupa.—The dorsum of the thorax of the pupa is granulated and carries about its middle a pair of small hooked bristles with their point turned inwards. Gill-tufts (fig. 11, B) containing an average of 30 filaments inserted on the edge of a rather long, hard and somewhat flattened horn, the surface of which is finely granulated. As a rule the filaments are as long as the horn itself and form a compact tuft curved inwards. These filaments are rather thinner than usual and present a strong segmented appearance.

Cocoon (fig. 13, B).—Elongated oval, its edge irregular and its texture rather coarse. The border of the anterior opening presents dorsally two long projections curved downwards so as to protect the two gill-tufts ; the dorsum of the cocoon is distinctly carinated in prolongation of the base of these projections.

The larvae and pupae of this species live on the stones of small and medium-sized cracks ; they have, however, been found occasionally on grass blades dipping in small rivulets. They seem to require only a moderately swift current of water.

Austrosimulium torrentium, sp. n.

Male.—Colour of body and vestiture exactly as in *A. tasmaniense,* with the exception of the knob of the halteres, which is entirely very dark ferruginous.

Antennae 10-jointed, first joint about half as long as the second, which is as long as wide ; the third not longer than the second but a little narrower ; the following joints not quite as long as wide and subequal to each other ; the last joint conical, not quite twice as long as wide. Palpi : third joint longer than the fourth by one quarter, fifth joint subequal to the third and somewhat fusiform. Legs exactly as in *A. tasmaniense,* including the structure of the hind metatarsi. Hypopygium : Claspers subequal in length to the side-pieces and provided at their extremity with two short teeth, aedoeagus as in *A. tasmaniense.*

This species is distinctly smaller than the two preceding ones, the size of the wings being only 2 mm.

Female.—Colouring of body and vestiture as in *A. tasmaniense,* including the halteres.

Antennae relatively shorter ; the fourth joint twice as long as broad, the following ones slightly increasing in length aad diminishing in width, the ninth being thus almost as wide as long ; the last joint relatively longer than in the male. Legs as in *A. tasmaniense,* the tarsal claws simple. Genitalia of the type given in fig. 5, B.

Length of wing 2 mm.

Type in the collection of the Cawthron Institute, obtained from a pupa collected at St. Patrick River, Northern Tasmania, 4.xi.1922. Allotype from the same locality and date.

Larva.—Length 4 mm. when full grown. It is more distinctly marked than that of the other Tasmanian species, the body being ornamented with blackish rings of ill-defined limits and position. Antennae one quarter longer than the basal piece of the mouth-fans ; their second joint is one third shorter than the first. Indentation of mentum as shown in fig. 9, B, the median and antepenultimate teeth on each side being conspicuously larger than the intermediate and terminal ones. Black gill spots small (as in fig. 6, D) ; only the longer filaments are folded upwards. The three anal gills are simple and of moderate length. Anal crown of hooks as in the preceding species, there being only 12 to 15 hooks in each row. The black anal armature (as in fig. 10, C) is much developed and has a quite peculiar shape, its base being in the form of a plate on which are inserted the two lateral undulated branches.

Pupa.—The anterior dorsal part of the pupal body is so shaped as to fit the circular opening of the cocoon like a flat operculum ; the dorsum of the head and only the anterior dorsal part of the thorax are delimited by a carina, which causes this lid to close tightly the opening of the cocoon from which the two small breathing tufts protrude. The dorsum of the head and of the exposed part of the thorax presents a kind of granulation, formed by small groups of very minute points ; against the posterior edge of the opening of the cocoon the thorax carries a pair of small but rather strong hooks pointing backwards. The gill tufts (fig. 11, E) are very small ; they do not overlap the anterior border of the head. They are composed of a basal

piece, orange in its proximal half, blackish on its distal part, and ending in three or four rather conspicuous dark spines, between and around which are inserted the breathing filaments. Their average number is 17, and their length $1\frac{1}{2}$ times that of the basal horn ; only a few filaments are of the same length as the horn.

Cocoon (fig. 13, E).—Its contour is usually circular, and it is very flat, the larva selecting, wherever possible, an indentation in the stone, which the cocoon closes like a flat lid. Sometimes the cocoon is of very reduced oblong shape, as shown in fig. 13, F ; this form has been found in the cataract gorge of Launceston, where the tremendous force of the current is very likely responsible for this modified shape.

A. torrentium in its early stages, and as an adult, has so far only been found in Tasmania in the following localities :—

Burnie (North-West) in October ; rather numerous larvae in the Emu River on stones ; one ♂ adult was then obtained from a pupa ; in the same locality in February the larvae and pupae were very numerous, but the adults were not observed.

Launceston (North), in the cataract gorge of the Esk River, several males and females were captured by sweeping plants in October. In November and January larvae and pupae were obtained from the river, and several imagines bred from them ; this species seems to be the only one existing in the Launceston gorge.

St. Patrick River. In November numerous larvae and a fair number of pupae were obtained from the river shingles, and several imagines were bred. This species was not found in the small neighbouring creeks.

Cradle Valley (N.W.) in January. The early stages were observed in Lilla Lake creek in company with other species ; also in numbers in the Dove River, where it seems to be the only species .

Mt. Farrel (W.). In February the larvae were seen in very great numbers on the stones of the Mackintosh River, but the pupae were then rather scarce.

This species was never met with in the south of Tasmania ; it seems to require a rather large stream to thrive well.

Austrosimulium weindorferi, sp. n.

In the adult stage this species in both sexes does not seem to differ from the preceding one ; the coloration and pubescence is exactly the same, as well as the relative lengths of the antennal joints and the conformation of the legs. Only the relative lengths of the palpal joints present some very slight differences, the third and fourth joints being equal and the fifth a little longer in this species, whereas in *torrentium* usually, and especially in the male, the third and fifth are subequal and the fourth is somewhat smaller. These differences are, however, not much to rely upon for certain identification.

All my specimens, 5 males and 19 females, were obtained from pupae collected in January on stones of Lilla Lake creek in the Cradle Valley, in company with the larvae and pupae of *A. tasmaniense* and *A. torrentium.*

Type in the collection of the Cawthron Institute,

Larva.—Length about 5 mm. when full grown. The blackish markings of the body very little conspicuous, as also those of the head. The two joints of the antennae subequal to each other and together longer by one-fourth than the basal piece of the mouth-fan. Indentation of the mentum as in the preceding species. Gill spots rather large (fig. 6, C), the filament tufts curved in the form of an S, the upper curve of the S touching the base of the filaments. Anal gills composed of three simple digitations. Anal hooks disposed in rows of about 12. The anal chitinous black armature (fig. 10, E) composed of two thin, very much twisted rods.

Pupa.—Dorsum of thorax distinctly granulated, the dorsum of the head also, but more finely, and presenting besides a number of small foveoles arranged in the form of a Y. The dorsum of the thorax carries posteriorly a pair of small, erect and rather stout hooked bristles, and before them a transverse concave row of six longer setae more or less undulated ; furthermore, in front there is another pair of similar setae. Gills (fig. 11, C) composed of a cylindrical, rather short basal horn, orange on its basal half and blackish on its distal part, with the end blunt ; the rather thin breathing filaments, which are about 30 in number, are about twice as long as the basal horn, and they are inserted all over the surface of the last part of this horn.

Cocoon (fig. 13, G).—Shape like a simple wall-pocket, and not provided with a wall between the support and the pupa ; the anterior opening is circular and is not tightly adapted to the pupa ; the texture of the cocoon is rather rough and sometimes intermingled with some filamentous algae (*Cladophora* sp.).

The early stages of this species were found only in the creek running out of Lake Lilla in the Cradle Valley, but not in the River Dove into which it runs, nor in the other small neighbouring creeks, such as the one coming out of Crater Lake. The optimum conditions required by the species seem therefore rather restricted.

As all the adults were obtained by breeding, no observations have been possible as to their biting habits.

Austrosimulium simile, sp. n.

Only the female of this species is known to me ; the relative lengths of the antennae and palpal joints are exactly the same as in *A. weindorferi*, as well as the other morphological features. I am therefore unable to differentiate between these two species, except in their early stages, which present some morphological differences, and different habits, chiefly in the pupal stage.

Larva.—When full grown it reaches 5 to 5·5 mm. The dark markings of the body are very little conspicuous ; those of the head also are of the usual pattern ; one median line with one spot on each side at the middle and another ill-defined spot between this and the base of the antennae on the suture of the prefrons. Antennae rather elongated, one half longer than the basal piece of the mouth-fans, the second joint subequal to the first. Mentum as in the preceding species (fig. 9, B). Gill spots elongated, as shown in fig. 6, B ; the filaments curved in an S. Three simple anal gills moderately developed. The rows of the posterior crown contain about 12 hooks each. The anal black chitinous armature is exactly like that of *A. weindorferi*.

Pupa.—About 3 mm. long. The dorsum of the thorax is very distinctly granulated and the dorsum of the head more finely so ; the peculiar pattern of foveoles on the head is the same as in *A. weindorferi*, and also the hairs and bristles of the thorax. The gills (fig. 11, D) are composed of a long, thin, orange horn, slightly curved inwards, on which extremity only are inserted about 20 filaments. These are rather thin and not quite twice as long as the basal piece.

Cocoon (fig. 13, D).—Wall-pocket-shaped, without any projection round its opening; its texture is rather rough and there is not any wall present between the abdomen of the pupa and the support, which is always of a vegetable nature.

Only five adult specimens, all females, were obtained by breeding from pupae collected in the different small creeks around Eagle-Hawk Neck, Tasmania, in November.

Pupae and larvae of this species were also obtained in the river at Geeveston, in Brown River near Hobart in December, and in Bruny Island in January. All these localities are in the South-East of Tasmania, to which this form seems to be restricted.

With one or two exceptions the early stages were found only on leaves, grass blades or bits of reeds dipping into the water.

Austrosimulium vexans, Mik.

Simulium vexans, Mik, Verh. zool.-bot. Ges. Wien, xxxi, p. 201 (1881).

Mik's description as given by Hutton (*) runs as follows :—

Female : "Nigro fuscum, polline cinerascenti obtectum, fronte thoracisque dorso orichalceo-pilosulis ; halteribus pallidis, pedibus fuscis, geniculis metatarsisque posticis pallidis. Alarum venis posterioribus sat crassis. Long. corp. 3 mm., long. alar. 3·3 mm."

According to information kindly given by Dr. Zerny, Mik's type seems to be lost, as it cannot be traced in the famous dipterist's collection. Captain Hutton found a few more specimens of this species in the Auckland Islands, the locality of the type ; they are still preserved in the collection of the Canterbury Museum, and through the kindness of Mr. G. Archey I have been able to examine them and to make some microscopic slides.

The description has to be completed as follows :—

Female.—Head with its appendages dark blackish grey, as well as the mesonotum, both with rather sparse yellow pubescence ; some longer black erect hairs in front and on the scutellum. Pleurae with grey tomentum and with a chestnut area under the wing base and on the mesosternum. Halteres pale yellow, the stem darker. Legs chestnut-brown ; all the knees orange, the hind ones more extensively so ; anterior tibiae yellowish orange on their inner side centrally ; hind metatarsi and second tarsal joint also lighter, but especially on their internal side, anterior metatarsi somewhat lighter on their basal half ; pubescence of the legs brown. Abdomen blackish brown with darkish pubescence, the lateral basal tufts yellowish ; the tergal plates of the segments 3–5 rather small and chestnut on the disk.

Frons one-quarter the width of the whole head (7 : 30).

Antennae ten-jointed ; the first joint half as long as the second, which is subequal to the third and as long as wide ; fourth joint nearly twice as wide as long, the following ones gradually increasing in size, the ninth being as wide as long ; last joint conical, twice as long as wide.

Palpi with the first two joints short, the third equal to the fifth and the fourth one-third shorter.

Wing venation as usual.

Legs : front tarsi not dilated, only a little longer than the middle ones ; hind legs moderately incrassate, the metatarsi not so wide as the tibiae, and provided with an internal distal lap which is as wide as the metatarsus itself and reaches the first third of the second tarsal joint ; the latter is narrow at its base but does not present a very distinct dorsal incision. Claws with a moderately large tooth at the base (fig. 3, B).

This species is quite distinct from all those from New Zealand ; on account of its toothed claws it can only be compared with *A. ungulatum*, from which it differs in the shape of the claws (which are not so much curved), in the smaller tooth, the wider lap at the extremity of the hind metatarsi, and the completely dark antennae.

Austrosimulium ungulatum, sp. n.

Female.—Antennae dark brown with the base of the third joint red. Head and mesonotum blackish brown with very short dense golden pubescence, which does not extend on the scutellum ; pleurae with grey reflection ; the little pleural tuft of hairs black. Halteres with whitish yellow knob and dark stem. Legs brown, with some dark ochraceous parts, namely, the extreme base of all the tibiae, the ventral

(*) Trans. N.Z. Inst. xxxiv, 1901, p. 169.

part of the front tibiae, the proximal half of the front and middle metatarsi, and nearly all the hind metatarsi except the tip and the ventral edge. Pubescence of the legs completely yellow. Abdomen dull black with very inconspicuous dark pubescence, the tufts of the basal segment yellow.

Antennae 10-jointed; the relative lengths of the joints about as in *A. vexans*. Palpi also similar, the last joint only being a little longer. Frons equal to a fourth of the whole width of the head. Venation as usual. Front and middle tarsi not dilated, the former a little longer than the latter. Hind metatarsi with a terminal lap nearly as wide as themselves, second tarsal joint with a very shallow incision at its base dorsally. Claws well curved, with a very conspicuous simple basal tooth (fig. 3, A). Genitalia as shown in fig. 5, B. Length of wing 3 mm.

Male unknown.

Type in the collection of the Cawthron Institute, collected at Reefton, 13.i.1922.

This wide-spread and frequent species has been found in the following localities in the South Island :—Nelson, all the year round; Mt. Arthur, 4,500 ft., December; Pokororo, December; Waiho, South Westland, January; Otira, Southern Alps, February; Lake Brenner, February; Kaikoura, East Coast, February; Dunedin, October; Kingston, September; Lake Manapuri, September, October; Doubtful Sound, September.

It has not yet been recorded from the North Island; it is a fierce biter.

It is very closely related to *A. vexans;* the points of difference between them have been given under the latter species.

Although this is one of the most common species, I did not succeed in obtaining its early stages even by breeding through a great number of larvae from the vicinity of Nelson, where *A. ungulatum* is frequently met with.

Austrosimulium australense, Schin.

Simulium australense, Schiner, Reise Fregatte Novara, Zool. ii, p. 15.

Schiner's description runs as follows :—

"Schwarzbraun, Ruckenschild heller bestäubt, um die Schulterecken gelb. Schenkel an der basis, die Beine um die Metatarsen gelblich. Flügel rein glashelle; die Randader welche die Flügelspitze bei weitem nicht erreicht, intensiv schwarz, die übrigen Adern bräunlichgelb; Discoidalader bis zur Querader dick, dann sehr unscheinbar, ihre Gabel kurz gestielt; Postical und Analader unscheinbar. $\frac{3}{4}'''$.—Auckland."

This description, which Schiner himself recognises as insufficient, could be applied to any of the six species found on the main islands of New Zealand.

Through the kindness of Dr. Zerny, I have been able to examine the type, which is preserved in the Vienna Museum. This female specimen, which was already in bad condition when in Schiner's hands, has now lost its head and abdomen. The thorax is without vestiture, and the wings and legs that remain do not give enough characters to arrive at a certain identification.

I am therefore giving below the description of both sexes of a species obtained from pupae collected in the vicinity of Auckland, the locality of the type.

Male.—Length of wing 2 mm. Body and appendages completely dark, blackish brown; the dorsum of the thorax and the abdomen velvety; the extreme base of the tibiae slightly ochraceous. Halteres completely black. Pubescence of the mesonotum of a very dark bronzy colour, short, adpressed, very dense and regularly distributed, not extending on the scutellum, which carries the usual longer erect black hairs as well as the prescutellar region. The pubescence of the abdomen and legs is also blackish.

Antennae ten-jointed; the first joint half the size of the second, which is as wide as long, and so is the third; the following ones are subequal in length, but their width gradually diminishes towards the extremity of the antennae, the last joint rather pointed, more than twice as long as wide.

Palpi with the third joint very little longer than the fourth, and somewhat shorter than the last ($5 : 4\frac{1}{2} : 6$).

Venation as usual.

Legs: front and middle tarsi not dilated, the middle ones longer; hind legs somewhat incrassate, the metatarsi without a row of bristles but provided with a rounded internal terminal lap which is but little narrower than the metatarsus itself; it reaches a little over the dorsal incision of the second tarsal joint.

Hypopygium with the claspers subequal in length to the side-pieces, and provided at their extremity with two or three teeth; very often two on one side and three on the other. The aedoeagus is, as usual, in the shape of a violin bridge.

Female.—Same size as the male; greyish black; antennae, palpi and legs brown; knob of halteres yellowish; pubescence of metanotum and legs yellowish, that of the abdomen brown with exception of the basal side-tufts, which are light.

The width of the frons is one-quarter that of the whole head. Antennae with the middle joints relatively shorter than in the male, being therefore distinctly wider than long. Palpi with the third and fourth joints subequal to each other, the fifth more than one half longer ($5 : 8\frac{1}{2}$). Wings and legs as in the male; the claws simple. Genitalia of the usual type.

Larva.—The larva of this New Zealand species does not differ from the majority of those of Australia. The dark markings of the body are little distinct, whereas those of the frontoclypeus are nearly always rather conspicuous; they are composed of a median line ending anteriorly in a series of dark points, and of a group of three points on each side of the middle of the median line, so that when seen at a low magnification the head seems to be provided on its basal two-thirds with a dark cross besides the dark edging round its base. The antennae (fig. 8, D) are distinctly longer than the basal piece of the mouth-fan; their very thin second joint is three times as long as the first cylindroconical joint. Thoracic gill spot as in fig. 7, G. The indentations of the mentum practically do not differ from those of most of the Australian species, *A. cornutum*, *A. torrentium*, etc., as shown in fig. 9, B. The anal gills are also composed of three simple, moderately long digitations. The anal armature on the dorsal side is as shown in fig. 10, A; it sends along the crown of hooks on each side a rod which stops in front of a small chitinous plate of variable shape, but generally triangular; these two small plates are united by a thin black rod at the base of the crown of hooks on the ventral side. The rows of the anal crown contain from ten to twelve hooks.

Pupa.—Dorsum of the thorax very finely granulated and carrying three pairs of very inconspicuous hairs. Breathing organs (fig. 12, G) composed of a long dark brown horn, flattened ventro-dorsally, and with subparallel sides in its basal half, its distal end tapering. The upper face of this horn carries longitudinal rows of very fine spinules that are also to be found on the sides. The breathing filaments number about 40 and are inserted especially on the edge of the horn and on its ventral face; these filaments are thin and flexible and vary in length from that of the horn to one-and-a-half times that length.

Cocoon.—The texture is moderately rough; it is in the shape of a wall-pocket with a rather tapering inferior end when it is built on some narrow support like a grass blade, but when built on a leaf it is much flatter and its contour is nearly circular.

Besides the specimens obtained at Auckland, this species has also been met with in the North Island at Te Aroha, Rotorua, Wairakei, Ohakune, and in the South Island at Nelson.

A. australense seems to go on breeding the whole year round. In its early stages this species is to be found only on the aquatic vegetation of small rivulets ; they favour especially watercress leaves, but they also breed on ordinary grass-blades or any other plant leaves dipping into the water. As mentioned in the chapter on the bionomics, this is a man-biting species, and its habitat seems to be chiefly the North Island of New Zealand.

Austrosimulium tillyardi, sp. n.

Male.—In the adult stage this species differs very little from the preceding one, *A. australense* ; some details of coloration, however, make differentiation possible. The legs are lighter, the base of the femora, the tibiae and part of the tarsi being of a dark ochraceous colour ; the legs seem lighter also on account of their short pubescence being completely bronzy yellow. The pubescence of the mesonotum is brassy yellow and distinctly longer than in *A. australense* ; that of the abdomen is also lighter. The knob of the halteres is of a dark ochraceous colour.

The antennae, palpi and legs present practically no difference in the relative lengths of their joints from those of the preceding species. The genitalia are also exactly the same, the claspers being sometimes provided with two or three teeth at their extremity.

Female.—Similar and scarcely distinguishable from *A. australense.* The pubescence of the mesonotum is somewhat coarser, longer and less dense. The legs are slightly lighter, their integument being of a dark ochraceous colour at base of femora, tibiae and metatarsi ; the pubescence, which is somewhat coarser and brighter, makes them also appear lighter.

Larva.—Similar to that of *A. australense*, from which it can only be distinguished when full grown by the shape and structure of the gill spots showing through the skin (fig. 7, I). The markings of the head are practically always so faint that no definite pattern can be made out. Anal armature as in fig. 10, F.

Pupa.—Dorsum of thorax coarsely granulated ; that of the head finely but very densely. Breathing organs (fig. 12, I) composed of a rather short, dark basal horn on the edge of which are inserted about fifteen rigid, rather thick filaments forming a compact tuft slightly bent inwards and about four times as long as the basal horn.

Cocoon.—Of a rather smooth texture ; it presents the shape of a slipper and is always closely adapted to the body of the pupa.

The *type* and allotype were obtained from pupae collected at Nelson in the Maitai River, where *A. tillyardi* in its early stages is to be found in great numbers all the year round on the shingles. I have collected this species in its early stages also in Aniseed Valley (Nelson district), Reefton (West Coast), on the Banks Peninsula (Little River, Purau Creek), and in the vicinity of Wellington. It has not been possible to ascertain if this species bites man.

Austrosimulium laticorne, sp. n.

In the adult stage and in both sexes this species is so exactly similar to *A. tillyardi* that it cannot be differentiated from it unless it be obtained through breeding from pupae, which in the structure of their breathing organs differ noticeably from the other species.

Several males and females were hatched from pupae collected at Waiho (West Coast, S.I.). They were found on some aquatic plants in a swift-flowing rivulet in company with *A. longicorne* and *A. multicorne*. A few pupae were also encountered on the shingle of the Maitai River at Nelson. This species seems therefore not to be restricted in its habitat.

Larva.—The larva is similar to those of the two preceding species; the markings of the head are as in *A. australense* but not nearly so distinct; the second bristle-like joint of the antennae is only about twice as long as the first in the full-grown larva. The gill spots are as shown fig. 7, K; the basal horn of the gill constitutes nearly the entirety of this spot, the filament being folded on it and scarcely overlapping its edges.

Pupa.—The pupa is characterized by its breathing organs (fig. 12, K), which are of a type related to those of *A. australense*, but here the black basal horn is much shorter and broader, more or less spatuliform; strongly flattened ventro-dorsally, its surface is very finely granulated but not spinulous; the filaments, which number 40 to 45, are short and thin, and inserted rather regularly over the whole surface of the horn dorsally and ventrally. The dorsum of the thorax is coarsely granulated as in *A. tillyardi*.

Cocoon (fig. 13, H).—In the shape of an oblong wall-pocket, and of a rather coarse cellular structure; it is always of a narrow shape, even when built on a flat surface.

Type and allotype from Waiho in the collection of the Cawthron Institute. This species was observed in numbers during January, but I have collected isolated pupae in Nelson towards the end of the winter. It is not certain that it bites man.

Austrosimulium multicorne, sp. n.

In the adult stage this species is exactly similar to the two preceding ones, but its size is somewhat larger, the wing length of the male being 2·5 mm. and that of the female 3 mm. It has been obtained from pupae differing widely from that of the other species in the conformation of their breathing organs.

Larva.—Length when full grown 6·5 mm. Markings of the head little distinct and when present of the same pattern as in the preceding species; the second joint of the antennae is only one-half longer than the first, which is about six times as long as broad. The gill spot is characterised by the tuft of numerous filaments curved upwards (fig. 7, H).

Pupa.—With dorsum of thorax rather coarsely granulated; breathing organs (fig. 12, H) composed of a short dark basal lance-shaped piece, on the edge of which are inserted distally about 35 long, thin, flexible breathing filaments; they are usually simple, but sometimes a few may be furcated towards the middle of their length. The cocoon, of smooth texture, is in the shape of a slipper.

Type and allotype obtained from pupae collected on Mt. Arthur tableland (4,000 ft.) in the collection of the Cawthron Institute; a good series of paratypes was obtained from the same locality, where the larvae and pupae were rather abundant on some aquatic grass in a small rivulet. Pupae of this species were also collected in the same kind of habitat at Waiho (West Coast, S.I.), Lake Brunner, Otira, on the East Coast at Kaikoura, and in the North Island at Ohakune from December till March.

Austrosimulium longicorne, sp. n.

The male and female of this species do not seem to differ from those of the preceding one, *A. multicorne*; they are also of the same size.

Larva.—Identical with that of *A. multicorne*, including the conformation of the antennae and the markings of head and body. The gill spots (fig. 7, J) are rather large and show the long filament coiled in a spiral.

Pupa.—Dorsum of thorax rather smooth, with a pair of small bristles. Breathing organ (fig. 12, J) composed of 10 to 15 slender flexible filaments nearly as long as the pupal body itself and branching from a very short common stem that is not strongly chitinous and cannot therefore be compared with the basal horns of the other New Zealand species. The number of these filaments varies according to individuals, and is often not the same on both sides ; sometimes one of the filaments, or very rarely two, may be bifurcated.

Cocoon.—Of smooth texture and in the shape of a wall-pocket ; that is to say, the inferior edge of the circular anterior opening touches the support.

The *type* and allotype of this species, which are in the collection of the Cawthron Institute, were obtained with a good series of paratypes from pupae collected at Kaikoura (East Coast, S.I.) in February. A few others were collected also at Waiho (West Coast), Ohakune and at Nihotapu (North Auckland). In all cases the early stages were found in small rivulets, either on aquatic grasses, watercress leaves, or on ordinary grass-blades dipping into the water. It has not been ascertained if this species bites man.

Summary.

1. In this paper five species of *Simulium* and 16 species of *Austrosimulium* are dealt with.

2. The new genus *Austrosimulium* differs mainly from the former in the number of joints in the antennae, which are ten instead of eleven ; it seems to be restricted to the Indo-Australian region.

3. In many cases the species of *Austrosimulium* cannot be differentiated from each other in the adult stage, although they are perfectly different in their early stages and especially in the pupal stage.

4. Seven species of *Austrosimulium* occur in New Zealand : *A. vexans*, Mik, *A. ungulatum*, sp. n., *A. australense*, Schin., *A. tillyardi*, sp. n., *A. longicorne*, sp. n., *A. multicorne*, sp. n., *A. laticorne*, sp. n. Only the first two of these are distinguishable from the others in the adult stage ; the remainder can only be differentiated in the pupal stage or the late larval stage.

5. Five out of these seven New Zealand species are known in their early stages.

6. In Australia (including Tasmania) five species of *Simulium* and nine of *Austrosimulium* are known to the writer, *i.e.* : *S. aurantiacum*, sp. n., *S. fergusoni*, sp. n., *S. ornatipes*, Skuse, *S. umbratorum*, sp. n., *S. terebrans*, sp. n., *A. crassipes*, sp. n., *A. cornutum*, sp. n., *A. tasmaniense*, sp. n., *A. victoriae*, Roub., *A. furiosum*, Skuse, *A. bancrofti*, Taylor, *A. torrentium*, sp. n., *A. simile*, sp. n., *A. weindorferi*, sp. n.

The two species *A. victoriae*, Roub., and *A. furiosum*, Skuse, have not been identified with certainty, so that further investigation may show that one or two of the new species are synonymous with them.

7. The early stages of one species of *Simulium* and five of *Austrosimulium* from Australia are here described.

MOSQUITO NOTES.—V.

By F. W. Edwards.

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I.—The Mosquito Fauna of the Solomon Islands and New Ireland.

In my recent revision of the mosquitos of the Australasian region the following species were mentioned as occurring in the Solomon Islands, the specimens having been for the most part collected by Dr. A. G. Carment :

Anopheles (*Myzomyia*) *punctulatus*, Dön.

Rachionotomyia solomonis, Edw.

Aëdes (*Ochlerotatus*) *imprimens* (Walk.).

Aëdes (*Aëdes*) *carmenti*, Edw.

Culex sitiens, Wied.

Culex annulirostris, Skuse.

So far as I am aware these are the only published records of the mosquitos occurring in these islands, but the following additions may now be made as the result of the study of fresh collections received from Dr. Carment, who is to be congratulated on his interesting discoveries.

Armigeres breinli (Taylor). Rere and Tulagi ; females only, determination therefore requires confirmation.

Aëdes (*Stegomyia*) *variegatus* (Dol.). Bred from empty coconut husk, also taken in house, Tulagi.

Aëdes (*Stegomyia*) *argenteus* (Poiret). Common in house, Tulagi.

Culex fatigans, Wied. With the last.

Rachionotomyia distigma, sp. n.

♀. *Head* clothed with azure scales above, silvery below. Clypeus and tori orange. Palpi black, hardly longer than the clypeus. Proboscis black, long and slender. *Thorax* with the integument mainly orange. Anterior pronotal lobes with flat black scales ; posterior pronotal lobes ("proepimera") with a few narrow dark scales. Mesonotum mainly clothed with straight hair-like greenish scales, but in front of the root of each wing is a roundish dark brown spot densely clothed with flat deep black scales. Dorsocentral bristles present (represented by scars). Three spiracular bristles. Pleurae with the usual patch of silvery scales ; integument of sternopleura and lower part of mesepimera dark brown. Scutellum denuded. *Abdomen* brownish with a strong purple gloss, but devoid of silvery markings.

Venter (as far as visible) golden. *Legs* dark brown, with a purple gloss. Femora pale beneath ; mid femora with one small obscurely pale spot in the middle in front ; hind femora with a dark dorsal line reaching the base, on the outer side pale golden, with the tip and a longish area beyond the middle dark. Hind tarsi with two small claws. *Wings* normal ; outstanding scales ligulate, rather short. Wing-length, 3·3 mm.

Tulagi, in house, 1♀ (*Dr. A. G. Carment*).

In many respects this answers to Taylor's description of *R. ornata*, but he describes the venter as " darker than the dorsal surface, clothed with blackish-brown scales ; " and does not mention any markings on the femora. The species is very distinct from all others known to the writer by the thoracic ornamentation.

Aëdes (Finlaya) albilabris, sp. n.

♀. Belongs to the group of *A. notoscriptus* (Skuse) and *A. pulcherrimus* (Taylor), differing from the former as follows :—Head with a median stripe of narrow silvery white scales, continuous with the white frontal line. Proboscis, in addition to the median white ring, with an elongate white mark above at the tip. White lines of mesonotum rather narrower and less conspicuous, the outer line interrupted at the sutural angle, the inwardly-bent portion being obsolete ; the short admedian lines merely represented by a few scattered golden scales. The small patches of white scales on the pleurae have a tendency to arrangement in longitudinal lines. Abdominal tergites all dark dorsally ; venter mainly dark, the sternites with ill-defined paler basal bands.

Tulagi, 27.ix.1923, " caught feeding in the morning," 1♀ (type) ; a second ♀ caught in house.

The species has rather a striking superficial resemblance to *A.* (*Stegomyia*) *variegatus* (Dol.).

In addition to the foregoing species from the Solomon Islands proper, a small collection was made by Dr. H. G. Wallace in New Ireland in February 1923, and forwarded for determination by Mr. G. F. Hill in May 1924. It included the following species :—

Armigeres lacuum, Edw.

Aëdes (*Stegomyia*) *albolineatus*, Theo.

Aëdes (*Aëdes*) *carmenti*, Edw.

Taeniorhynchus (*Coquillettidia*) *brevicellulus*, Theo.

Culex (*Lophopoceratomyia*) *fraudatrix*, Theo.

Hodgesia ? *cairnsensis*, Tayl.

It is somewhat surprising that the only species common to the two lists is *Aëdes carmenti*.

II.—The first Theobaldia found in New Zealand.

Theobaldia tonnoiri, sp. n.

♀. *Head* with dark integument, clothed with golden scales. Proboscis dark brown, paler beneath before the middle, rather longer than the front femora. Palpi only about one-eighth as long as the proboscis, with a small but distinct terminal segment, which is whitish and apparently devoid of scales ; the long penultimate segment with dark brown scales and a few pale ones at the base. Tori yellow, clypeus dark brown, bare. *Thorax* with the integument dull reddish brown ; scutellum, pleural sutures, and a spot in the middle of the mesepimeron pale ochreous. Scales of anterior pronotal lobes unusually long and hair-like, pale golden ; those of posterior

pronotal lobes similar but shorter. Mesonotal and scutellar scales rather scanty, golden, a patch of brown ones behind each shoulder. Two small patches of long creamy scales on the sternopleura, and one in the middle of the mesepimera over the pale spot. Three rather long golden spiracular bristles; one dark lower mesepimeral bristle. *Abdomen* dark brown with a purple gloss, the golden hairs on the hind margins of the tergites giving a slight appearance of banding. *Legs* dark brown; undersides of femora and outer side of hind femora, a narrow but distinct preapical ring on all femora, and tips of femora and tibiae (most noticeably those of the hind tibiae) ochreous. First hind tarsal segment almost as long as the tibiae. *Wings* with a dark patch on the membrane across the outer end of the upper basal cell, and another, less conspicuous, in the base of cell *Cu* 1. Scales long, dense, lanceolate, dark brown in colour, those at the bases of the fork-cells, on *Rs* and on the portion of *M* below *Rs* practically black, giving the wing a spotted appearance somewhat as in *Anopheles maculipennis*. Upper fork-cell quite four times as long as its stem, its base slightly proximal to that of the lower. Cross veins widely separated. Halteres with ochreous stem and black knob. Wing-length 4·8 mm.

New Zealand: Waiho, 16.i.1922, 1♀ (*A. Tonnoir*). Type in the Canterbury Museum, Christchurch, N.Z.

In its comparatively small size, dark tarsi and general appearance this species shows affinity with the Australian species of the genus (*T. frenchi*, Theo.), but is of special interest on account of the markings of the wings and femora, which resemble those of the European species.

III.—An Addition to the Oriental Pitcher-plant Fauna.

Uranotaenia xanthomelaena, sp. n.

♂. *Head* with black scales and bristles; palpi and proboscis black-scaled; antennae black; clypeus and tori dark brown. Proboscis scarcely as long as the abdomen or front femora, somewhat swollen on the apical third. *Thorax* with the integument uniformly light ochreous, mesonotum rather scantily clothed with small narrow scales of the same colour; scutellum and pleurae with flat scales, also of the same colour and difficult to detect. No flat scales in front of wings. *Abdomen* clothed dorsally with light brownish-ochreous scales, ventrally with pale ochreous; no markings. *Legs* with the coxae and trochanters pale ochreous; femora and tibiae black, the latter narrowly ochreous at the tips; tarsi with light ochreous rings at joints (embracing both ends of the segments), much broader on the hind legs; on all the legs the fifth segment is entirely ochreous. No special modifications of the legs. *Wings* with normal venation. Scales all brownish, rather elongate oval. Wing-length 2·5 mm.

Larva: *Head* rather long and narrow, almost twice as long as wide, brownish in colour. All the clypeal hairs very small, simple and crowded close together on the anterior fifth of the clypeus; inner post-antennal hair a little stouter than the others but by no means spine-like. Antennae very short, barely four times as long as broad, black; tuft very minute, two- or three-haired. Mentum with a large central tooth, and about five shorter blunt teeth on each side. *Thorax* too much damaged for description. *Abdomen* with long stout black bristles on each segment, all set in small chitinised plates; segments 1–3 each with two such bristles on each side, segments 4–7 with one only; also other small hairs whose correct position cannot be ascertained owing to the shrivelling of the skin. Eighth segment with large lateral plates, bearing on their posterior margins a row of four or five long spines, slightly and evenly fringed all round. *Siphon* extremely short, only as long as broad, with a pecten of four large teeth, which are sharply pointed and slightly serrate on both margins, equidistant from one another and from the base and tip of the siphon.

Tuft two-haired, situate at about two-thirds of the length of the siphon. Valves rather large, quite half as long as the siphon. Sub-siphonal hair stout, black, slightly plumose, but not branched at the base. *Anal segment* nearly twice as long as broad, smooth, without spines but with a moderately long stout black hair (double on one side) in the middle of its posterior margin. Two pairs of long black dorsal hairs; beard moderate, black.

FED. MALAY STATES: "Ravine J.9," Kuala Lumpur; one larva found in pitcher-plant; pupated 1. iv. 1923, male emerged 5. iv. 1923 (*Dr. H. P. Hacker*). Type male and larval skin presented to the British Museum by the collector.

By the combination of ringed tarsi and pale ochreous thorax this species is sharply marked off from all the other species of the genus hitherto described. The larva also shows some very distinctive features, notably in the clypeal hairs and the extreme shortness of the siphon; in both these points it appears to resemble the larva of *U. ascidiicola*, de Meij., which also lives in pitcher-plants, but this differs in having multiple abdominal tufts.

IV.—On the Identity of certain Type Specimens.

During a recent visit to Holland I took the opportunity of examining the types of the mosquitos described by van der Wulp from North America, Java and Sumatra. The specimens are in a fair state of preservation in the museum at Leyden, in the charge of Mr. van Eecke, to whose courtesy I am indebted for facilities in making the examination. I give herewith notes on these species and on certain others described by Theobald and Enderlein.

Anopheles annularis, Wulp.

As is indeed evident from the original description, this belongs not to the *hyrcanus* but to the *fuliginosus* group. It may be identical with *A. fuliginosus*, or may be a more or less distinct regional form, but a more detailed comparison and further study of Javan material will be necessary before this can be decided.

Anopheles annulimanus, Wulp.

Synonymous with *A. maculipennis*, Mg., or *A. quadrimaculatus*, Say; probably with the latter, as already indicated by Howard, Dyar and Knab. The "rings" on the tibiae are merely due to rubbing.

Culex crassipes, Wulp.

Evidently the same as Theobald's *Taeniorhynchus brevicellulus*, which name must now give place to the older one proposed by van der Wulp.

Culex longipalpis, Wulp.

The type female is a specimen of *Taeniorhynchus* (*Mansonioides*) *annulipes* (Walk.); a second female appears to be *T.* (*M.*) *uniformis*, Theo. Walker's name holds good for *M. annulipes*, of which *C. longipalpis* must be treated as a synonym.

Culex testaceus, Wulp.

Both Theobald and Dyar prove to have been quite at sea in their guesses as to the identity of this form. The type, though rubbed and without the tip of the abdomen, is quite recognisable as a specimen of *Taeniorhynchus perturbans* (Walk.). The name *apicalis*, Adams, may therefore be used without further question for the species of *Culex* formerly wrongly identified as *C. territans*, Walk. Van der Wulp's name sinks as a synonym of *T. perturbans*.

Kingia alberti, Theo.

The type of this species is in the Congo Museum at Tervueren, in very poor condition. It has no hind legs, and it seems clear that Theobald mistook the middle legs for the hind pair and described them as such. The black scales on the lateral lobes of the scutellum as well as most of the other characters agree well with *Aëdes apicoargenteus* (Theo.). I could not detect a silvery spot on the front of the middle femora, but this may have been rubbed off, and in any case its absence would hardly form a sufficient specific distinction, as it is variable in size (sometimes very small) in *A. apicoargenteus*, of which *K. alberti* may be regarded as a synonym.

Kingia maculoabdominalis, Theo.

This is in the collection of the Liverpool School of Tropical Medicine, as are the remaining types of Theobald mentioned below. It is in perfect condition, except for the loss of the hind legs. From my examination and from information kindly supplied me subsequently by Miss A. M. Evans, I find it is identical with *Aëdes* (*Stegomyia*) *fraseri*, Edw. ; Theobald's name is later and therefore sinks.

Aëdimorphus quinquepunctatus, Theo.

Identical with the earlier described *A. argenteopunctatus*, Theo. The middle as well as the hind femora have round white preapical spots in front.

Reedomyia sudanensis, Theo.

Probably identical with the earlier *Aëdes tarsalis* (Newst.). The description of the ornamentation of the head does not agree with *A. tarsalis*, but in the type the eye-margins are not silvery as stated but pale ochreous. In any case the name is preoccupied by *Culex sudanensis*, Theo.

Grabhamia caballa, Theo.

I did not examine the type of this species, but Miss A. M. Evans has kindly done so, and confirms my suspicion that it is the same as my *Ochlerotatus chelli*. Theobald's name has precedence.

Culicelsa centropunctata, Theo.

The Gold Coast species I have previously identified as *Aëdes* (*Ochlerotatus*) *sudanensis* (Theo.) must be referred here. Although appearing structurally identical with *A. sudanensis* it differs in regard to the ornamentation of the thorax and abdomen and may be a distinct species. In the type of *C. sudanensis* the mesonotal scales are much lighter in colour and the pale bands of the abdomen broad and complete. /o

Mucidus nigerrimus, Theo.

This is apparently identical with the much earlier described *M. mucidus*, Karsch, which I now consider to be distinct from the West African *M. africanus*, Theo. The eastern *M. mucidus* differs in having distinct white rings in the middle of the mid and hind tibiae, as well as at the base and tip, and in the second segment of the hind tarsi being white only on the basal half instead of white to the tip.

Chrysoconops nocturnus, Theo.

Synonymous with *Taeniorhynchus cristatus*, Theo. The mesonotal process referred to in the description is merely a sharp angle, and the dark basal rings on the hind tibiae are hardly perceptible.

Heptaphlebomyia kingii, Theo.

Evidently synonymous with *Culex argenteopunctatus*, Ventr.

10 **Lepiothauma furfurea,** End.

I am indebted to Dr. G. Enderlein for the loan of this and the two following types from the collections of the Zoological Museum, Berlin. *L. furfurea* proves, as I suspected, to be a synonym of a species of *Aëdomyia*, but in view of the recorded locality (Kamerun) it is surprising to find that it is not *A. africana*, N.-L., but *A. venustipes* (Skuse). I have in a previous paper (Bull. Ent. Res. vii, p. 229, 1917) mentioned the main differences between *A. africana* and *A. venustipes* (=*catastica*), the latter having till now been presumed to be Oriental and Australian only. A re-examination of the material confirms the distinctness of the two species, and shows that *A. venustipes* differs further from *A. africana* in its rather larger size and in having long outstanding scales towards the base of the hind tibiae, especially on the underside. The type of *L. furfurea* is damaged, but clearly shows all the diagnostic characters of *A. venustipes*.

Aniella togoensis, End.

The lateral lobes of the scutellum are rubbed completely bare, but all the other characters of the specimen agree with *Aëdes* (*Stegomyia*) *apicoargenteus*, Theo., so that the identity of these two may be assumed and Enderlein's name sunk as a synonym of Theobald's species.

Aniella ziemanni, End.

In this also the lateral lobes of the scutellum are rubbed, and so is the anterior surface of the middle femora. Assuming that the former had black scales and the latter a white spot in the middle, the species is extremely close to *A. apicoargenteus*, differing almost solely in the black-scaled fourth hind tarsal segment.

V.—Two New Species from Nyasaland.

Aëdes (Stegomyia) subargenteus, sp. n.

♀. *Head* with the usual flat scales ; a very few narrow ones on the nape. Scales round the orbits metallic silver, at the sides pure white ; in the middle above is a broad whitish-ochreous stripe, narrowed towards the front between the two rather large blackish patches. Clypeus bare, shining black. Tori black with some silvery scales. Palpi nearly one-fourth as long as the proboscis, tip broadly snow-white on the upper surface. Proboscis all black. *Thorax* with blackish integument. Prothoracic lobes with broad silvery-white scales ; proepimera with a small patch of similar scales. Mesonotum having the scales of the ground-colour narrow, curved, black ; a small patch of silvery racquet-shaped scales in the middle of the front margin, from which two distinct and fairly broad lines of narrow golden scales extend backwards to the scutellum. The usual pair of patches of broad, slightly curved, snow-white scales are present on the anterior half of the mesonotum ; they are rather smaller than in most allied species, somewhat oval in shape and pointed behind ; from them extend backwards to the lateral lobes of the scutellum a second pair of golden lines, composed of broadish curved scales. A small patch of broad snow-white scales a little in front of the root of each wing. Bristles all golden-yellow, the supra-alar tuft very conspicuous. Scutellum completely covered with snow-white scales ; bristles golden-yellow, four on the mid lobe. Pleurae with the usual patches of flat silvery scales. No lower mesepimeral bristles. *Abdomen* black, with creamy-white basal bands on tergites 3–6 and metallic silvery lateral spots on tergites 1–7. *Legs* : front femora black with a narrow ochreous line anteriorly on the basal half, posteriorly more ochreous. Front tibiae black with a narrow white basal ring. Front and middle tarsi black with narrow white basal rings on the first two segments. Middle femora black, with a round silvery spot on the anterior surface beyond the middle and another larger on the antero-dorsal surface close before the tip. Middle

tibiae entirely black. Hind femora with the basal third white all round, the rest black, but with two silvery spots as on the middle femora. Hind tarsi black, each segment with a white ring at the base, the last two slightly narrower than the first three. Front and middle claws with small teeth. *Wings* normal ; wing-length 3 mm.

♂. Resembles the ♀ in coloration. Hypopygium much as in *A. argenteus*, but the clasper more curved, not swollen in the middle, with a stout blunt terminal spine at right angles to the main axis ; the lobes of the ninth tergite short and broad, with numerous long bristles.

NYASALAND : Fort Johnston, 1. vi. 1923 (*Dr. W. A. Lamborn*). Type ♀ presented to the British Museum by the Imperial Bureau of Entomology ; also 2 ♂ 3 ♀ reared from eggs laid by the type, the description being completed in some details from these specimens.

In describing recently *A.* (*S.*) *woodi* from Nyasaland (Bull. Ent. Res. xiii, p. 82) I remarked that it showed a closer approach than any other known species to *A.* (*S.*) *argenteus*. The present species, however, is in some respects even nearer to *A. argenteus*, but yet differs in many details both from this and from *A. woodi*.

Larva.—The single (4th stage) larva sent by Dr. Lamborn resembles that of *A. argenteus*, but shows the following well-marked distinctions :—Head and siphon pale in colour. No hairs in the middle of the prothorax overlapping the occiput. No definite spine, but only a blunt knob, associated with the lower lateral tuft of the metathorax. Small mid-dorsal hairs of abdominal segments apparently absent. Teeth of comb less definitely trifid. Siphon relatively more slender, and therefore appearing longer, index about 2·2 ; pecten with fewer teeth (8–10 instead of 12–16) ; siphonal hair rather long and simple instead of shorter and trifid.

Pupa.—The specimen sent resembles that of *A. argenteus*, but the terminal bristle on the paddles is shorter.

Mimomyia pallida, sp. n.

Nearly allied to *M. hispida* (Theo.), differing as follows :—Postnotum pale ochreous, like the pleura. Abdomen distinctly banded in both sexes, the pale bands not narrowed in the middle. Tarsi with a much more distinct yellow spot at the base of the first segment. First segment of the antennal flagellum of the female shorter, barely twice as long as the second segment. Male hypopygium with the bristles on the ninth tergite more numerous (about 6–8 instead of 3).

NYASALAND : Fort Johnston, 24. xi. and 31. xii. 1923 (*Dr. W. A. Lamborn*) ; 2♂ 1♀ (cotypes) presented to the British Museum by the Imperial Bureau of Entomology. UGANDA : Kibanga, 3. ix. 1910 (*Major A. D. Fraser*) ; 1♀ presented by the collector.

In *M. hispida* the postnotum is darkened in the middle, and the pale bands of the abdomen are either narrowed in the middle or more or less broadly interrupted.

VI.—A NEW WEST AFRICAN AËDES.

During a recent re-examination of the British Museum series of *Aëdes cumminsi* (Theo.) I noted the presence in some specimens but not in others of fine hairs on the lower part of the mesepimera. I have called attention to this feature (in my recent paper on Australasian mosquitos) as occurring in a number of Oriental species of the restricted subgenus *Aëdes*, but have not otherwise observed it in any other subgenus. Its occurrence in one form only among the African species of the subgenus *Aëdimorphus* shows that it can have no great systematic importance, though it may, perhaps, be taken as another piece of evidence indicating the close affinity of these two subgenera.

On separation from the rest of the series of *A. cumminsi* the specimens with lower mesepimeral hairs were seen to possess some other slight distinguishing features, and they may therefore be treated as representing a distinct species.

Aëdes (Aëdimorphus) pubescens, sp. n.

Differs from *A. cumminsi,* Theo., as follows :—Mesepimera on the lower half with about a dozen short fine hairs towards the posterior margin. Scales of head and towards sides of mesonotum with a much more pronounced golden tinge. Hind femora on the underside dark-scaled for a considerable distance, though occasionally leaving a narrow external whitish line which reaches through to the tip (in *A. cumminsi* the hind femora are always distinctly white to the tip on the outer side, with very few dark scales beneath). Lobes of male aedoeagus (as seen from above) with strong knob-like projections externally (these being practically absent in *A. cumminsi*).

Sierra Leone : Daru, 29. vii. 1912 (*Dr. J. J. Simpson*) ; type ♂. Gold Coast : Kumasi, 22–26. x. 1907, 2♂ ; Obuasi, 20. xi. 1907, 1♀; Dunkwa, 2. vii. 1907, 1♀; " 118 m. G.C.R., 11. viii. 1907, caught in bush," 1♀ (*Dr. W. M. Graham*).

The remaining West African specimens of *A. cumminsi*, including several from the Gold Coast, are of the variety with small whitish median basal spots on the abdominal tergites, which Theobald described as *Culicada mediopunctata* (=*C. fuscopalpalis*, Theo., ♂).

VII.—On the Grouping of the Ethiopian Species of Aëdes (sens. lat.), with Notes on certain Species.

Since the African mosquitos were revised by the present writer in 1912 a large number of additional species have been described, and the classification of some groups has been elaborated in more detail. A fresh revision is therefore desirable. In a recent paper I have summarised the present position with regard to the genus *Culex*, and now purpose to do the same for the genus *Aëdes* (in the widest sense).

In my paper of 1912 I admitted as distinct genera *Stegomyia, Howardina, Ochlerotatus* and *Banksinella*. All these are now merged in *Aëdes*, but retained (except the second) as subgenera ; on the other hand, three subgeneric divisions of *Ochlerotatus* have been admitted. These subgenera have been defined in my papers on the Palaearctic and Australasian mosquito faunas (Bull. Ent. Res. xii, 1921, and xiv, 1924) and the diagnoses need not therefore be repeated here, but the species of each will be considered in order. The most striking feature of the Ethiopian fauna is the abundance of species of the subgenus *Aëdimorphus*. *Finlaya,* so well developed in the Oriental region, is here poorly represented.

Genus **Armigeres,** Theo.

I mention this here because, although I have in recent papers admitted the genus as distinct from *Aëdes*, the two are so close that they may have to be reunited. The two Ethiopian species agree with the typical Oriental forms in ornamentation and in having a row of spines on the male claspers, but have a long slender proboscis, and in this respect approach *Aëdes.*

Subgenus **Stegomyia,** Theo.

In a recent paper Dr. G. Enderlein has suggested retaining the name *Stegomyia* for those species in which the eyes are well separated, and proposes the new genus *Aniella* for those in which the eyes are practically touching, without a scaled area between them. On this basis *A. argenteus* and the species of the *A. albopictus*

group would constitute the genus *Stegomyia*, while most of the remaining Ethiopian species would be placed in *Aniella*. There might seem to be an apparent justification for this course in that *A. argenteus* and *A. albopictus* have similar larvae with few stellate tufts on the abdomen, while many of the other species have densely spiny larvae. I believe, however, that both these characters are of little importance. In regard to the eyes, it may be noted that the degree of approximation varies in different species of this and other subgenera of *Aëdes*, but there are few if any species in which they are definitely in contact for a considerable distance, as they very frequently are in *Culex*. In any case Enderlein's *Aniella* is evidently the same as Theobald's *Kingia*, the type species being very closely allied.

It seems more natural to arrange the numerous Ethiopian representatives of this subgenus in five distinct groups, which may be defined as follows :—

Group I. The *vittatus* group. Especially remarkable in the adult for the presence of about four well-marked lower mesepimeral bristles, all the other species of the subgenus being devoid of such bristles. This feature, together with peculiarities of the hypopygium and larva, shows clearly that the species is not a true *Stegomyia*, and it may have to be removed from the subgenus. The single species, *A. vittatus*, Big. (*sugens*, Theo., *nec* Wied.), is also well distinguished by its ornamentation (femora and tibiae with white rings, etc.).

Group II. The *africanus* group. Posterior pronotal lobes (" proepimera ") completely covered with flat silvery or golden scales. Mesonotum with a pair of patches of similar scales somewhat transversely placed in front of the sutural angles, and continuous with the pronotal patches. A single median golden line on the mesonotum. Hind tarsi with white rings at the bases of the first three segments (that on the third very broad), last two segments mostly or all dark.

A. africanus (Theo.) (=*Stegomyia dubia*, Theo.).

A. luteocephalus (Newst.).

Group III. The *argenteus* group. Posterior pronotal lobes with flat white or silvery scales below, narrow dark ones above. Mesonotum with a pair of crescent-shaped or rounded patches of pure white scales in front of the sutural angles, another pair of smaller patches in front of the wing-roots. Claws of female nearly always toothed. This includes the majority of the Ethiopian species of the subgenus, and may be divided into two series as follows :—

i. The *argenteus* series. Seventh abdominal tergite with large lateral silvery patches (visible dorsally) but without median basal patch, the remaining tergites generally conspicuously banded. Traces of a *pair* of median golden lines on the mesonotum, extending at least a short distance forwards from the antescutellar space (except in *A. metallicus*). Hind tibiae all black.

A. argenteus (Poiret) (=*S. fasciata*, auct., *S. nigeria*, Theo.).

A. subargenteus, Edw.

A. simpsoni (Theo.) (=*S. bromeliae*, Theo., *S. lilii*, Theo.).

A. metallicus, Edw. (=*Quasistegomyia dubia*, Theo.).

A. woodi, Edw.

Of these species, *A. argenteus* is distinguished from the other four by having a white line instead of a round white spot on the anterior surface of the middle femora, as well as by its scaly clypeus and thoracic markings. The last three all have the fourth hind tarsal segment all black, but *A. metallicus* is well distinguished by the large patch of flat silvery scales in front of the scutellum, and *A. woodi* by the black instead of white scales on the lateral lobes of the scutellum.

ii. The *apicoargenteus* series. Seventh abdominal tergite with a median basal white or silvery spot, but the lateral spots generally less conspicuous than in the

argenteus series. Traces of a *single* median golden line on the mesonotum, extending at least a short distance forward from the antescutellar space (except in *A. chaussieri*). Fourth hind tarsal segment largely or all white (except in *A. ziemanni*).

a. Hind tibiae all black.

A. chaussieri, Edw.

A. masseyi, Edw.

The latter of these differs from the former in having the third hind tarsal segment all black and the small white spot on the front margin of the mesonotum composed of narrow instead of broad scales.

b. Hind tibiae with a white patch at or near the base on the lower or outer side.

A. apicoargenteus (Theo.) (=*alberti*, Theo.; *togoensis*, End.).

A. fraseri, Edw. (=*Kingia maculoabdominalis*, Theo.).

A. dendrophila, Edw.

A. ziemanni (Enderlein).

A. pseudonigeria (Theo.) (=*S. wellmani*, Theo.).

A. poweri, Theo.

A. calceatus, Edw.

A. soleatus, Edw.

In the first four of the above the abdomen is without distinct bands on the first three or four tergites; while in the last four, conspicuous white bands are present on at least tergites 3–7. Further, *A. apicoargenteus* differs from the rest in having black instead of white scales on the lateral lobes of the scutellum; *A. dendrophila* and *A. pseudonigeria* in having no white spot in the middle of the anterior surface of the middle femora; and *A. ziemanni* in having the fourth hind tarsal segment all dark.

Group IV. The *albopictus* group. Posterior pronotal lobes clothed as in the *argenteus* group, but mesonotum with a thin white median line and no presutural white patches; female claws generally simple. This group is typically Oriental, but three species occur within the Ethiopian region; only the first, however, on the African mainland.

A. unilineatus (Theo.) (=*S. gebeleinensis*, Theo.).

A. albopictus (Skuse) (=*S. scutellaris*, Theo. *nec* Walk.; *S. lamberti*, Ventr.).

A. granti (Theo.).

A. unilineatus differs from *A. albopictus* in the presence of small round white spots on the disc of the mesonotum and on the front of the middle femora. *A. granti* (known only from the type from Sokotra) is very distinct from the other two, the proboscis having a white line above, the mesonotum having a white marginal line, curving inwards at the suture, and the costa being white towards the base.

Group V. The *mascarensis* group. Posterior pronotal lobes devoid of scales and with only two or three bristles. Mesonotum with the anterior half or more covered with narrow silvery-white scales. All segments of hind tarsi white-ringed at base. A single species, *A. mascarensis*, MacGregor.

Subgenus **Skusea**, Theo.

Only two closely related Ethiopian species belong here:—

A. pembaensis, Theo. (=*Phagomyia mutica*, End.).

A. cartroni (Ventr.).

These belong to the typical group of the subgenus, with long male palpi resembling those of some species of *Aëdimorphus*. *A. cartroni* differs from *A. pembaensis* in having narrow pale bands on the abdomen. In *A. pembaensis* the female has one or sometimes two lower mesepimeral bristles, but the male has none. This is the only instance I have so far observed among mosquitos of sexual dimorphism in the chaetotaxy.

Subgenus **Aëdimorphus,** Theo.

As stated above, this is the subgenus which is most extensively represented in the Ethiopian region. I would include here both the *domesticus* and the *vexans* groups (*i.e.*, the groups *Aëdimorphus* and *Ecculex* as outlined by me in 1917), since there appears to be no fundamental difference between them and they grade insensibly into one another. Whether the *furcifer* and *apicoannulatus* groups should also be placed here is more open to question, but these species have the male claspers apparently forked, much as in the species of the *vexans* group, owing to the subterminal position of the spine.

Group I. The *furcifer* group. Posterior pronotal lobes practically covered with broad flat scales. Post-spiracular scales present. Lower mesepimeral bristles present (1–3). Male hypopygium with a tuft of long scales at the apex of the side-piece on the inner side; no definite basal lobe. Female cerci short, abdomen rather blunt-tipped. Tarsi ringed. Head and scutellum with flat scales.

A. furcifer (Edw.) (=*Diceromyia africana*, Theo.).

A. adersi (Edw.).

A. fascipalpis (Edw.).

The first two species are remarkable for having all the wing-scales very broad, somewhat as in *Mansonioides*. They are geographical (western and eastern) forms of the same type, differing only in small details. The third species has normal narrow wing-scales, but exhibits all the features of the group as defined above, and is certainly related to the other two. It is of interest as forming a connecting link with more typical *Aëdimorphus*.

Group II. The *apicoannulatus* group. Posterior pronotal lobes bare, except for a few dark scales above. No scales on post-spiracular area. No lower mesepimeral bristles. Male hypopygium without scale-tuft; side-piece with small hairy basal lobe. Female cerci short, the abdomen rather blunt-tipped. Tori silvery-scaled. Head and thorax with silvery-white markings formed by patches of broad scales; scutellum so clothed. Hind tarsi with white rings at the apices of the segments. Five closely related species belong here :—

A. marshalli (Theo.).

A. simulans (Newstead & Carter).

A. capensis (Edw.).

A. apicoannulatus (Edw.).

A. haworthi, Edw.

In the first two the silvery areas on the front of the mesonotum are small, extending only half the length of the posterior pronotal lobes, and there are silvery spots in the middle of the mesonotum and on the femora; *A. simulans* differs from *A. marshalli* in having spots on the hind femora only and the mesonotal spots composed of narrow scales. In the last three species the silvery areas on the front of the mesonotum are larger, extending the whole length of the posterior pronotal lobes, and the femora are unspotted; among these, *A. capensis* is distinguished by the presence of silvery spots on the disc of the mesonotum, and *A. haworthi* differs from *A. apicoannulatus* in the much broader silvery mesonotal stripes.

Group III. The *domesticus* group. Posterior pronotal lobes almost bare below, with some narrow dark scales above. No post-spiracular scales. No lower mesepimeral bristles. Side-piece of male hypopygium without basal lobe; clasper much swollen apically. Female cerci long and distinct, the abdomen tapering. Tori bare. Scutellum with flat white or silvery-white scales. Lateral abdominal spots silvery-white. Tarsi dark.

This group connects the *apicoannulatus* group with the *vexans* group, and includes the following five Ethiopian species, besides some Oriental forms :—

A. domesticus (Theo.).

A. argenteopunctatus (Theo.) (=*A. quinquepunctata*, Theo.).

A. punctothoracis (Theo.).

A. minutus (Theo.).

A. tarsalis (Newst.) (= *R. biannulata*, Theo., *R. sudanensis*, Theo., *D. africana*, Newst., etc.).

In the first three the mesonotum has distinct silvery spots composed of broad scales. *A. domesticus* differs from its two associates in having the small lateral lobes of the mesonotum (in front of the wing base) bare, while in the others they are clothed with flat white scales. In *A. argenteopunctatus* the mid and hind femora have silvery pre-apical spots, which are absent in *A. punctothoracis*. *A. minutus* differs from *A. tarsalis* in having the head scales mostly flat.

Group IV. The *vexans* group. Posterior pronotal lobes mainly covered with scales, which are mostly or all narrow and usually for the most part pale in colour. At least a few post-spiracular scales present, mixed with the bristles. No lower mesepimeral bristles. Male hypopygium with the basal lobe of the side-piece usually more or less developed (absent in *abnormalis, irritans* and *nigricephalus*; small in *albocephalus* and *alboventralis*); claspers various. Female cerci long and distinct, the abdomen tapering. Tori either bare or with small inconspicuous scales. Scales of scutellum and lateral abdominal spots dull white or creamy.

This includes numerous Ethiopian and a few Oriental species. The typical species of the group (*A. vexans*, Mg.) apparently does not occur on the African mainland south of the Sahara, being represented by the closely allied *A. sudanensis* and *A. hirsutus*. The following series are fairly well distinguished :—

1. The *albocephalus* series. Some or all of the scutellar scales broad and flat, at least in the male. Tarsi dark. Basal lobe of male side-piece small or absent.

A. abnormalis (Theo.).

A. alboventralis (Theo.).

A. rhecter, Dyar.

A. seychellensis (Theo.).

A. albocephalus (Theo.).

A. nigricephalus (Theo.).

A. irritans, Theo.

In the first three species the male clasper is of peculiar form, enlarged apically, with a terminal row of modified bristles. *A. rhecter* may possibly be the same as *A. seychellensis*, the male of which is unknown. *A. nigricephalus* is well distinguished from the other members of the series by its general black colour.

2. The *lamborni* series. Scutellum with flat creamy-white scales. Hind tarsi with broad white rings embracing both ends of the segments. Basal lobe of male side-piece well developed. A single species, *A. lamborni*, Edw.

3. The *dentatus* series. Scutellum with narrow scales only. Basal lobe of male side-piece well developed. Postspiracular scales broad. Hind tarsi dark, or with two faint rings only (*bevisi*).

A. cumminsi (Theo.) (with var. *mediopunctata*, Theo.).

A. pubescens, Edw.

A. caliginosus (Graham).

A. quasiunivittatus (Theo.).

A. leucarthrius (Speiser) (? var. of *quasiunivittatus*).

A. dentatus (Theo.).

A. bevisi, Edw.

4. The *vexans* series. As in the last, but hind tarsi with conspicuous white rings at bases of segments.

A. vexans, Mg. (= ? *arabiensis*, Patton).

A. sudanensis (Theo.). (= *Culex sudanensis*, Theo.).

A. centropunctatus (Theo.) (? var. of *sudanensis*).

A. hirsutus (Theo.).

A. durbanensis (Theo.).

A. nigeriensis (Theo.).

5. The *ochraceus* series. Scutellar and postspiracular scales all narrow. Femora and tibiae lined in front; tarsi dark. Basal lobe of male side-piece absent. One species, *A. ochraceus* (Theo.), with its Oriental representative *A. pallidostriatus* (Theo.).

Subgenus **Banksinella**, Theo.

I have nothing further to add to my tabulation of the African species of this subgenus (Bull. Ent. Res. v, pp. 273–274, 1915).

Subgenus **Finlaya**, Theo.

There are only four Ethiopian species of this subgenus at present known. In all of them there is a broad white basal ring on the second segment of the hind tarsi; some also have a narrow white ring at the base of the first hind tarsal segment, but the remainder of the hind tarsus is dark. This tarsal coloration is not found in any other species of the subgenus.

Group I. The *longipalpis* group. Posterior pronotal lobes completely covered with large rounded silvery scales; a large patch of such scales just in front of each wing-base, and a median stripe of similar scales running the whole length of the mesonotum.

A. longipalpis (Grünb.) (= *S. pollinctor*, Graham).

A. fulgens (Edw.).

The latter is the East African representative of the former, and differs chiefly in the much longer female palpi, which are over half as long as the proboscis. Owing to their conspicuous ornamentation the species are apt to be mistaken for *Stegomyia*.

Group II. The *wellmani* group. No metallic scales anywhere on the body. Scales of posterior pronotal lobes largely narrow.

A. wellmani (Theo.).

A. barnardi, Edw.

The latter is apparently the Cape representative of the former, differing chiefly in having three narrow pale lines instead of a rather large white patch on the front of the mesonotum, the margins of which are much more narrowly white.

Subgenus **Ochlerotatus,** Arr.

Only two Ethiopian species belong here: *A. caballus* (Theo.) (*chelli,* Edw.) and *A. fryeri* (Theo.). The former is a typical *Ochlerotatus* with mesepimeral bristles and well-marked claspettes and apical lobe to the male side-piece. The latter belongs to the *taeniorhynchus* group, having no lower mesepimeral bristles, no apical lobe to side-piece, and the claspette reduced, its appendage bristle-like; this may evidently be regarded as the Ethiopian representative of *A. taeniorhynchus* (Wied.), both being sea-coast forms like the Australasian *A. vigilax* (Skuse). In ornamentation it closely resembles species of the *vexans* series of *Aëdimorphus.*

A CONTRIBUTION TO THE BIOLOGY OF *ORNITHODORUS MOUBATA*, MURRAY.

By B. Jobling.
(*From the Wellcome Bureau of Scientific Research, London.*)

(Plate VIII.)

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Introduction.

In September 1923 I was asked by Dr. C. M. Wenyon to undertake the breeding of the tick, *Ornithodorus moubata*, female specimens of which were sent to the Wellcome Bureau by Dr. Kelesberger from the Belgian Congo. This gave me an opportunity of carrying out a series of experimental investigations on the biology of the tick which were continued till August 1924. The results obtained form the subject of this paper.

The biology of *O. moubata* has already been investigated by Cunliffe (1921), therefore in this paper I will only briefly refer to the facts already known, and will deal chiefly with those which throw new light on the biology of this tick.

I wish to thank the Director of the Bureau, Dr. C. M. Wenyon, C.M.G., C.B.E., for placing this material at my disposal, and Mr. W. J. Muggleton, Chief Assistant of the Bureau, whose valuable assistance has greatly facilitated my work.

Methods of Breeding and Feeding the Ticks.

All the stages of the tick—eggs, larvae, nymphs and adults (♀ and ♂)—were kept in glass tubes containing a small amount of clean sand. The openings of the tubes were not plugged with cotton-wool, since the tick is incapable of climbing up the vertical walls of glass vessels, if the latter are sufficiently clean and free from deposit. The tubes containing the ticks were placed in large jars, the bottoms of which were covered with slightly moist cotton-wool, and were kept in an incubator at 29·5°–30° C.

The ticks were fed at a room temperature (16°–18° C.) on the ear of a rabbit placed in a box which was designed for the purpose of abstracting blood from the veins of the ear. In order to keep the ear of the rabbit in position whilst the ticks are feeding, a stand shown in text-fig. 1 was devised. It consists of a wooden block (*a*) to which a piece of box-wood (*b*), measuring 4 by 3 inches, is attached in the form of a platform. Across the latter are placed two rubber bands (*c*), slightly extended and attached by their ends on either side of the block. The distance between the

bands should not be less than $2\frac{1}{4}$ inches. The height of the stand should be equal to the level of the rabbit's ear stretched horizontally, when the animal is in the box. For feeding purposes the rabbit's ear is drawn between the wooden platform and the rubber bands, which keep it in a comfortable position and prevent the animal from shaking the ear.

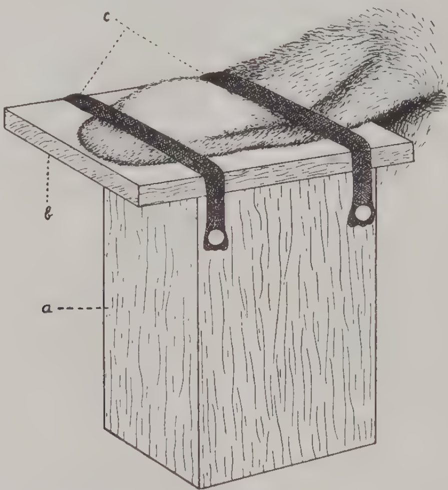

Fig. 1. Apparatus for feeding the ticks on a rabbit's ear.

The ticks about to be fed are placed on a shaved surface of the rabbit's ear under a wide glass tube, which is covered by a duster to shade it from the light, which makes the ticks restless. When exposed to light the ticks frequently take a long time to start feeding. As soon as the ticks had attached themselves and had commenced to suck blood, the tube and duster were removed and they were allowed to feed until they dropped off of their own accord.

The egg, the larva and their development.

The shape, coloration and dimensions of the egg have been described in detail by different authors (Dutton & Todd, 1905; Nuttall & Warburton, 1908; Cunliffe & Nuttall, 1921). In the majority of eggs measured by me the mean ratio of the large to the small diameter was 0·9 by 0·8 mm.*

In fig. 1, Pl. viii, an egg is shown immediately after it had been laid. In most cases by the end of the first day an opalescence can be observed in the egg. The embryo can first be detected as a series of whitish dots. On the fourth day after oviposition (Pl. viii, fig. 2) it is quite distinct, and three pairs of elongated piriform structures, which represent the rudiments of the future legs, can be detected. On the sixth or seventh day the embryo already occupies the whole egg. At this period the legs have a conical form and are bent inwards; the mouth-parts and palps appear in the form of three spots in the anterior region of the embryo, whilst immediately behind the mouth-parts, under the first pair of legs, the ovoid ganglion, slightly

* I have also observed eggs in which the ratio of length to width was abnormally high, the shape being occasionally almost cylindrical. Eggs which were slightly piriform in shape were noted. Such eggs, however, occurred very rarely and were found in the latest batches (4, 5 and 6), but gave rise to perfectly normal larvae.

notched on its anterior surface, makes its appearance. Nearer to the posterior end, in the median line, the anus is visible as a light dot. On the seventh, and sometimes towards the end of the sixth day, a trilobed spot representing excretory crystals accumulated in the region of the rectum appears near the anal aperture. In general features the embryonic development of *O. moubata* is similar to that of *O. savignyi* described by Christophers (1906).

In most cases the larva is ready to emerge from the egg on the eighth day. Hatching is effected by alternate contractions of the anterior and posterior ends of the body of the larva. As the result of these contractions the egg-shell becomes detached from the body of the larva and gathered into deep folds. When viewed laterally such an egg is pear-shaped. As the posterior end of the larva dilates and contracts more than the anterior end, the egg-shell becomes ruptured posteriorly (Pl. viii, figs. 4, 5, 6 and 7). The continued pulsations serve to extend the rupture, until the entire dorsal surface of the larva becomes free from the shell which gathers into folds on the ventral surface at the anterior end of the body (Pl. viii, figs. 8 and 9). At this period the contractions of the larval body cease. In many cases the whole egg-shell becomes detached (Pl. viii, figs. 10 and 11), but in the majority it remains on the ventral surface of the larva forming a kind of sheath for the capitulum and the second and third pairs of legs. A slight movement of the legs can be observed under the intermediate power of the binocular microscope.

It is interesting to note that the larva, which is active during the process of emerging from the egg, becomes motionless as soon as it has freed itself from the egg-shell, and is incapable of feeding. It remains in this condition till the first ecdysis, after which the very active first nymph stage appears, and this is capable of feeding.

According to Cunliffe, the interval between oviposition and the appearance of the larvae at 30° C. averages 10 days, with a minimum of 8 and a maximum of 13 days. My observations on 163 batches of eggs kept at 29·5°–30° C. gave the following figures in days: minimum 7, maximum 11, average 8. The calculations were made by separating each batch laid by a female during one night and keeping the batches in separate tubes.

The Nymphs.

About one day before the first ecdysis the larva becomes paler in colour, while the mouth-parts, capitulum and legs become shrunken and lose their original shape entirely. Just before ecdysis the skin of the larva becomes detached from the nymph developing within it, the grooves disappear, and it assumes a more convex form. Under the binocular the limbs and outlines of the future nymph become distinctly visible. At the points where the skin of the larva is in touch with the nymph mammilae can be seen. Along the anterior end, on a line passing near the dorsal portion of the base of the capitulum, a light streak is visible—the site of the future rupture of the larval skin. The rupture is effected by pressure of the first and second pairs of legs on this line and proceeds in a sagittal direction. At first the front pair of legs is freed, then the second, third and fourth. After all the four pairs of extremities have become free the nymph abandons the larval skin (text-fig. 2). The egg-shell becomes detached when the first and second pairs of legs are liberated, or, if the larva emerges from the egg by its anterior end, the shell remains attached to the larval skin.

The interval between the hatching of the larva and the first nymph stage at 29·5°–30° C. averages 4 days (min. 3, max. 5). The observations were made on 145 batches of larvae. Thus the first nymph stage appears on an average 12 days after oviposition. As regards the number of nymph stages before the mature stage is reached, I have not observed the six or seven recorded by Cunliffe. In my experiments the majority of males appeared after the fourth ecdysis, and the females after the fifth. In one instance observed by me a female appeared after the fourth ecdysis,

as in the case of males. Observations on the interval between two successive ecdyses fully confirm those of Cunliffe, who found that the time at which ecdysis commenced depended, not upon the preceding ecdysis, but upon the preceding meal.

Interval between ecdysis and succeeding feeding, in days :—

30 ticks kept at 29·5°C.–30°C.

Stage.	*Min.*	*Max.*	*Mean.*
1st	3	12	5
2nd	1	4	2
3rd	1	5	2
4th	1	5	2

Nymphs of the first stage require more time before they are capable of feeding than nymphs of succeeding stages, which are ready to feed, on an average, two days after ecdysis. It can frequently be observed that nymphs of the first stage introduce their mouth-parts into the rabbit's skin and remain in this position for hours without ingesting blood. This phenomenon may also be observed in nymphs of the second, third, fourth and other stages, but is of much rarer occurrence than in nymphs of the first stage.

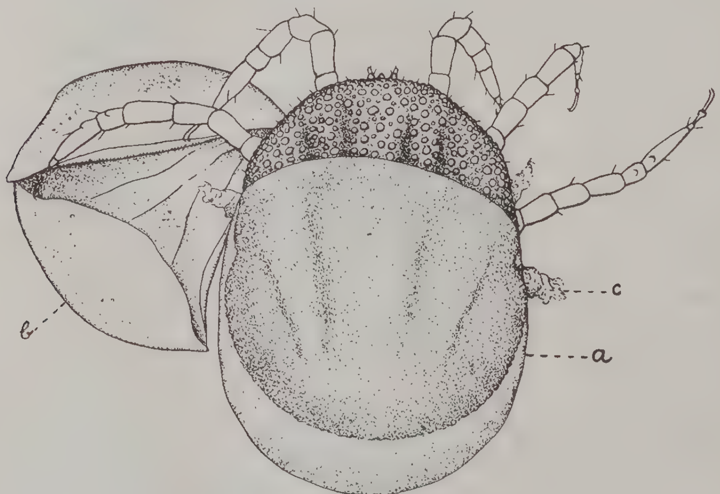

Fig. 2. Nymph of *Ornithodorus moubata* emerging from the larval skin.

The moment when the tick starts gorging itself with blood can be determined by examining it through a hand-lens, when it can easily be observed that this moment coincides with the commencement of rapid peristaltic movements of the diverticula of the mid-gut. The blood entering the tick's gut probably stimulates this reflex. From three to five minutes later the body of the tick swells up, after which the discharge of the transparent secretion from the coxal glands commences. The coxal fluid is secreted by all the nymph stages, as also by the adults (text-fig. 3). In the first nymph stage the fluid can be seen, if several nymphs are fed together on a small patch of the rabbit's skin. The secretion of the fluid ceases several minutes after the engorged tick falls off. When feeding the body of the tick alternately swells so as to assume an ovoid form with a smooth surface and contracts with the production of depressions on the dorsal surface.

Length of feeding time of nymphs in minutes :—

No. of ticks.	*Stage.*	*Min.*	*Max.*	*Mean.*
522	1	13	87	25·7
431	2	11	54	21·0
471	3	11	42	20·2
411	4	17	53	26·3

In this experiment the time indicates the interval between the commencement of ingestion and the moment the ticks withdraw their proboscis and move away.

Fig. 3. *Ornithodorus moubata* secreting coxal fluid.

The first nymph stage occupies more time in completely engorging itself than the second and third stages, in which the mean times are equal. This is probably due to the fact that in the first nymph stage the process of feeding is slower than in the succeeding stages. Nymphs of the stages which precede the adult may require a larger amount of nutritive material. In accordance with this "the adult of either sex may take its largest meal either before or after maturity" (Cunliffe).

The ratio of males to females is practically equal. Thus, from one batch of 163 eggs, 72 males and 67 females were hatched. The greatest mortality of individuals during the development occurs in the egg and larval stages. The nymphs are nearly all capable of development to the adult stage.

A complete series of experiments on the influence of feeding upon the development of ticks was interrupted by an accidental rise of temperature in the incubator, which killed all the ticks.

The Males.

The interval between the last ecdysis and feeding is much longer in the case of males than in nymphs and females. The impulse of the males to feed is subservient to the sexual instincts, as is manifest from their behaviour when a large number are placed on the rabbit's ear to feed. Very few start feeding, the majority behaving towards other males as they do when they encounter females.

Unfed males are capable of fertilising females, as the following experiments show :—Two unfed males, A. and B., were placed in separate tubes. To each of them females were introduced immediately after ecdysis. Fertilized females with

spermatophores attached to the vulva were isolated and kept in separate tubes until they laid eggs, while new females were put with the males. Male A. fertilized four females before it fed, and four after feeding, making a total of eight females during the period between 2nd November and 2nd December 1923 ; it died in March 1924. Male B. fertilised three females before feeding, and seven after feeding—a total of ten females from 2nd November to 2nd January 1924 ; it died in February. All the females fertilised by these males laid six batches of fertile eggs.

The length of feeding time in minutes, as observed in 268 males, was : minimum 9, maximum 42, mean 16·1. The average time during which the males remain attached when feeding on the rabbit is less than that of nymphs, and half that of females. After feeding, the males become less active and are not so eager to fertilise. Males that have just fed behave like nymphs that have completed their meal ; they avoid strong light and rapidly bury themselves in the sand. Three or four days after the meal the males again become active and readily fertilise females.

The Females.

As was previously established by Cunliffe (1921) the females can be fertilised immediately after the last ecdysis. I was able to observe that a female placed in contact with many males can be fertilised four or more times in succession. I have found females with three and four spermatophores attached to the vulva, a fact which indicates that several males had taken part in fertilisation. The female can also be fertilised after having already laid several batches of eggs.

The interval between the last ecdysis and the time when the females start feeding is equal to that in nymphs of the 2nd, 3rd and 4th stages.

The length of feeding time in minutes, as observed in 258 females, was : minimum, 21, maximum 92, mean 35·2. This shows that the average time during which the females feed is longer than in the nymphs and twice as long as in the males. In succeeding feeds the times occupied by females differ little from that of the first feed.

Oviposition.

In making observations on the interval which elapsed between a feed and oviposition, the following facts were taken into consideration :—(1) "a fertilised female did not oviposit until after it had fed" (Wellman, quoted by Cunliffe, 1921), (2) "females may be fertilised before engorgement" (Cunliffe). As both these phenomena occur in these ticks, it is obvious that in the case of a female which had fed several days before fertilisation the interval of time preceding oviposition should be calculated from the time of fertilisation. It follows that the interval must be shorter than in the case of a female which had fed after fertilisation and in which the moment of commencement of oviposition depends upon the time when feeding occurred.

In order to elucidate this point three experiments were conducted. In each experiment females which had moulted at the same time were employed immediately after the last ecdysis.

(1) 39 ♀ were fed on the same day ; 25 days after feeding all the females were fertilised. The interval between fertilisation and oviposition in these females averaged 6 days (min. 5, max. 9).

(2) 26 ♀ were fertilised on the same day ; 25 days after fertilisation all the females were fed. The interval between feeding and oviposition averaged 9 days (min. 8, max. 11).

(3) 41 ♀ were fertilised immediately after feeding. The interval between fertilisation and feeding to oviposition averaged 9 days (min. 8, max. 12).

The results of these experiments fully confirm the statements made above. The retardation (on the average, 3 days) of the time between fertilisation and oviposition (exp. 1) takes place at the expense of the interval of time between feeding and fertilisation, during which the eggs in the female develop from the material assimilated from the food.

The results of the second and third experiments show that the period of time between fertilisation and feeding has absolutely no effect upon the period between feeding and oviposition.

The period between the succeeding meals and the ovipositions following them (batches 2, 3, 4, 5 and 6) averaged 8 days (min. 6, max. 13). In this case oviposition depends upon the preceding meal, although it must be noted that in rare cases the interval of time varies considerably. In one case a female laid eggs 25 days after feeding.

According to Cunliffe (1921) the maximum number of eggs laid by a female at 30° C. after each feed is 318, the minimum 28. The number of eggs laid by one female at the same temperature is 488, the percentage of fertile eggs being 58.

The table below represents the results of my observations on nine females kept at 29–30° C.

No. of ♀.	No. of eggs in batches.						Total no. of eggs in batches.	Percentage of fertile eggs in batches.
	1st.	2nd.	3rd.	4th.	5th.	6th.		
1	143	149	130	138	104	35	699	88·9
2	120	175	173	175	150	95	888	72·4
3	268	232	226	208	136	147	1,217	85·2
4	156	158	181	158	61	103	817	87·8
5	109	134	135	148	87	80	693	85·2
6	152	167	170	141	106	82	818	86·5
7	164	173	171	148	85	97	838	92·4
8	207	244	245	208	97	104	1,105	78·7
9	165	157	152	120	146	82	822	86·4

From this table it is seen that the greatest number of eggs are laid by females in the first batches (1st and 2nd) after the first and second meals. In the succeeding batches the number of eggs diminishes, and in the last, sixth batch, laid after the sixth meal, the number of eggs is in most cases one-half or two-thirds the number in the first batch. Moreover, if the percentage of developing eggs is compared in the first and sixth batches, it will be found that on an average in the former 96·8 per cent. develop, whilst in the sixth only 14·5 per cent. develop. The percentage of eggs capable of development gradually declines to the fifth batch, and it may happen that none develop at all in the sixth batch. It is also interesting to note that if the female lays a small number of eggs in the fifth batch the number of eggs in the sixth batch increases (females No. 4 and 8). The diminution of the number of eggs in the last batches, and especially in the sixth, is due to senescence. A very evident loss of vitality is noted after the sixth batch of eggs is laid, the female becoming less motile and refusing to feed. This depression has the effect of lowering the percentage of eggs capable of development.

In order to ascertain whether this failure is due to absence of spermatozoa, I have dissected six females after they have laid the sixth batch of eggs, and found small numbers of spermatozoa in the genital organs of all of them.

The maximum number of eggs laid by one female was found to be 1,217. The percentage of eggs capable of developing was on the average 84·5. The smallest number of eggs laid after a meal was 35, and the largest 340.*

According to Dutton & Todd, " the productivity of the female is certainly increased by large feeding." Therefore, if the female takes a smaller meal, the number of eggs laid after such a meal should be smaller. Five females, after having fed normally and laid the first batches of eggs, were fed again for a period of only 10 minutes each. The number of eggs, both of the first and second batches, were counted with a view to ascertaining the difference in productivity. The results are shown in the following table :—

No. of the female.	1st Batch.	2nd Batch.	Difference.
1	229	66	163
2	189	59	130
3	146	37	109
4	160	48	112
5	215	71	144

This experiment fully confirms the statement quoted above. It is, however, not quite complete, as, owing to an accident, I failed to obtain the third batches of eggs which should have been laid after the third normal feeding of these females.

Oviposition takes place during the night, as noted by previous observers. " Only few eggs are matured at one time : oviposition therefore goes on slowly " (Dutton & Todd) ; " it only lasted on the average for ten days " (Cunliffe).

It is rather difficult to determine the exact time occupied by a female in laying one batch of eggs, as the process is a slow one, and part of the batch is always covered by the body of the tick. Observations on this point conducted on 126 females placed in glass tubes with a thin layer of sand on the bottom gave the following figures at 29·5°–30° C.—average 7 days (min. 2, max. 12). During the first few days the female lays more eggs at night than towards the end of oviposition. After the eggs have been laid the female does not immediately abandon them, but in most cases remains on them several days longer, leaving them when many have already developed into larvae, and some of the larvae have even developed into nymphs. From five to ten of the latter may usually be seen clinging to the ventral surface of the female. This phenomenon is very interesting from the point of view of the dissemination of nymphs of the first stage by the female. If set free, such a female is capable of crawling a long distance without losing a single nymph.

Two females, one carrying 5 and the other 8 nymphs, were allowed to crawl more than 15 feet in the room. Only one of them dropped a nymph and that was when it fell from the table to the floor. This interesting habit of transporting nymphs suggests a method of their dissemination which is in need of further observations in the field and in the laboratory.

* Observations on this female were interrupted.

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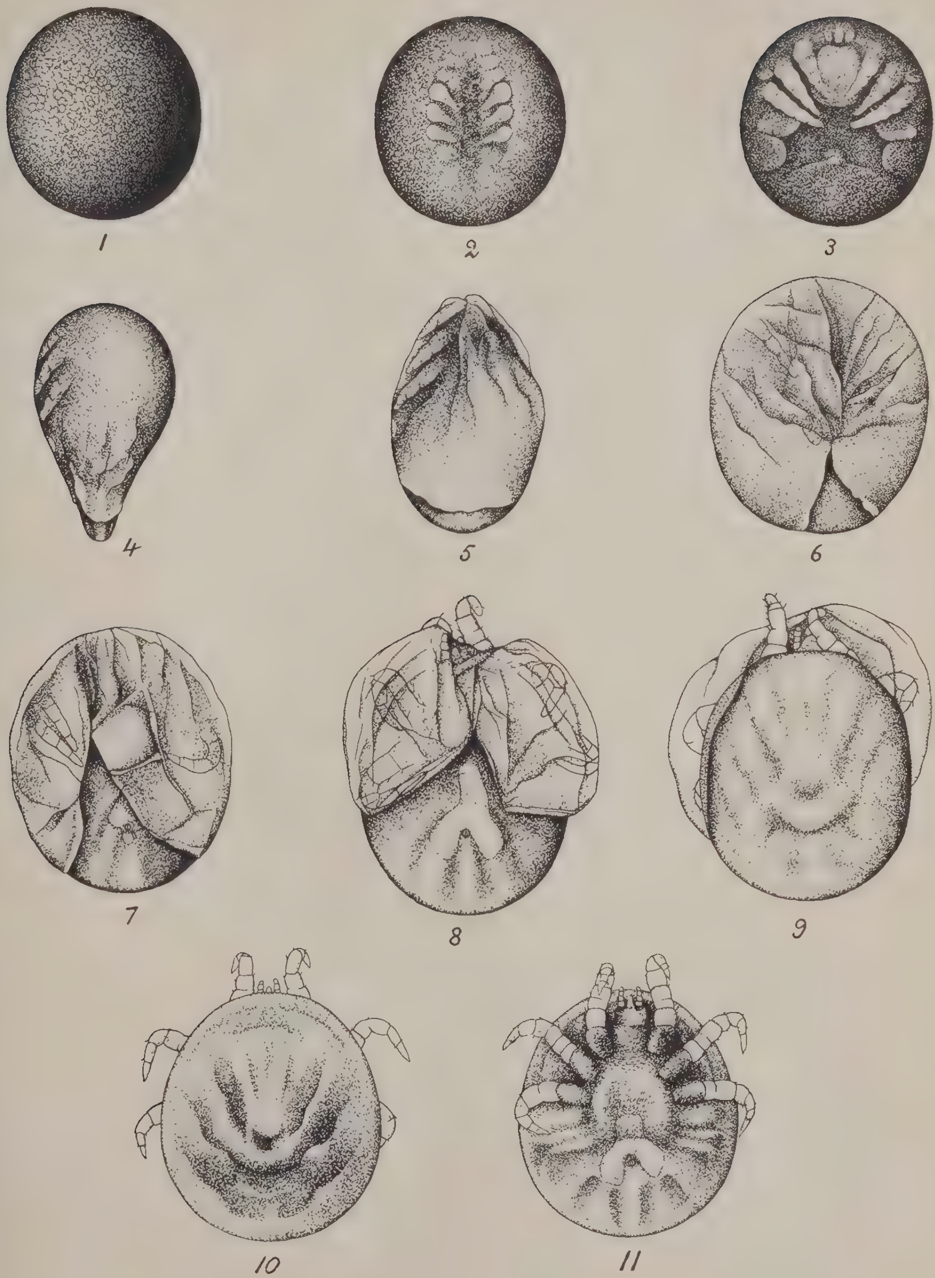
EXPLANATION OF PLATE VIII.

Fig. 1. Egg just laid.
,, 2. Embryo on the fourth day.
,, 3. Embryo on the sixth-seventh day.
,, 4. Side view of hatching egg; contraction of the posterior and expansion of the anterior ends.
,, 5. The same; contraction of the anterior and expansion of the posterior ends.
,, 6. Appearance of rupture in the egg-shell.
,, 7. Advanced stage of hatching.
,, 8. Ventral view of hatched larva with the egg-shell attached to it.
,, 9. Dorsal view of the same larva.
,, 10. Dorsal view of larva free from the egg-shell.
,, 11. Ventral view of the same larva.



The Hatching of *Ornithodorus moubata*. (All figures ×32.)

THE CITRUS COCCIDAE OF THE WORLD.

An Appeal for Co-operation and Aid.

By Joseph Conrad Chamberlin,
Citrus Experiment Station of the University of California, Riverside, California.

About two months ago there was begun, under the auspices of the University of California Citrus Experiment Station, the task of monographing, as adequately as possible, the Citrus Coccidae of the world. Obviously, the scope of such an undertaking is such that an enormous amount of laborious work is required in the compilation and synthesis of scattered and partially " buried " scraps of recorded data. Even this collated information will not meet the requirements of our problem. This is particularly the case as regards geographical distribution, alternate and preferred hosts, and proper correlation of the data of distribution and damage with that of the geographical distribution and economic status of *Citrus* itself.

There are now recorded in the neighbourhood of 130 to 140 distinct species of scale-insects and mealy-bugs which infest *Citrus* to a greater or less degree. Many of these are at present of little economic importance in a citricultural sense, either because of adjacent preferred hosts, abundant natural enemies, climatic conditions, or geographical isolation far from important citrus centres. Nevertheless, as may be rather tritely observed, *all* are of very real, potential or actual danger to the industry. The removal of one or more of these restraining factors is all that is necessary to make an actual enemy of a species that was previously only potential. This is, of course, most spectacularly shown in foreign introductions.

It would consequently be of great value, in a true international sense, if a complete and accurate manual of all the citrus-feeding Coccidae were readily available. This need is what the here-proposed monograph is designed to fill.

In addition to " keys " to the species and completely illustrated systematic descriptions it is intended to treat of the general appearance in life, the " habit " or mode and severity of attack, climatic effects, a brief list and discussion of natural enemies (predators and parasites) and diseases, geographical distribution, alternate and preferred hosts, complete bibliography and synonyms, and, finally, correlation of these data so far as possible with the distribution and importance of commercial citrus plantings themselves.

For this manual to fulfil in any considerable degree the outlines indicated above, wholehearted and truly international co-operation and support of entomologists and citriculturists everywhere is required.

The cosmopolitan character and appeal with which it is desired to invest this monograph can only result from such co-operation and aid. This, then, is the content of my request.

For the guidance of those who desire to co-operate in this project the following points may be listed as of importance.

1. A list of *all Citrus* scale-insects or mealy-bugs attacking in *any degree* commercial or ornamental plantings of any of the varieties of *Citrus*, with notes as to their relative economic importance in the district (which may be large or small) under consideration.

2. Alternate and preferred hosts.

3. Actual specimens or material—particularly of rare or sporadic and " unknown " species.

4. Extent, acreage, varieties and approximate value of the "raw" citrus products. (This information is readily available only for the United States, Spain, Algeria, Italy and possibly Palestine.) These data are desired, as before noted, to facilitate the closest possible correlation between the extent and value of *Citrus* plantings themselves and the geographical distribution and economic danger of the pests.

5. Local common names.

Suggestions, comments and criticism of this work or any of its phases will be especially welcomed. All help or co-operation of any sort will be greatly appreciated personally, and acknowledged both personally and publicly.

In conclusion, it might be worth while to call attention to the fact that such a work as this will be of value not only to those directly or indirectly interested in *Citrus* as such, but also to most other workers in, and growers of, other subtropical and tropical fruits. This is because most of the really serious "pests" are rather extensive in distribution and catholic in taste. Their ravages are only rarely confined to a single species or genus of plants. Then, too, many of them are only more or less incidental on *Citrus*, doing the bulk of their damage to other crops. For example, *Aspidiotus perniciosus*, the San José scale, is of only very minor importance on *Citrus*, but is extremely dangerous on other hosts, as all economic entomologists and horticulturists can testify.

NEW CERATOPOGONINAE FROM NYASALAND (DIPT.).

By A. Ingram & J. W. S. Macfie.

Culicoides lamborni, sp. n.

Length of body (one male), 2·3 mm.; length of wing, 1·6 mm.; greatest breadth of wing, 0·5 to 0·6 mm. A large, dark brown species resembling *C. nigripennis*, C.I. & M.

Head dark brown. Eyes incompletely separated above by a wedge-shaped plate of chitin at the apex of which is inserted a large bristle. Clypeus and proboscis dark brown. Palpi (fig. 1, *c*) dark brown; the third segment inflated in its distal half and furnished with a very large, shallow sensory pit. *Antennae* brown, the last three segments darker brown, and the torus almost black. Third segment large, with a long stalk, and bearing on its distal third numerous small sensory pits. Segments 3 to 6 armed with very long, straight, tapering spines. Segments 4 to 11 irregularly oblong, progressively diminishing in size from about 16 by 10 to 10 by 8 units;* twelfth segment slightly longer, about 13 units. Segments 13 to 15 elongated, about six or seven times as long as broad, subequal, or the 13th a little longer than the other two, the last segment ending rather bluntly. *Thorax* dark brown, adornment indistinguishable in the specimens examined, which had been mounted in balsam. Scutellum very dark brown, bearing about nine bristles, and seven small hairs. Post-scutellum very dark brown. *Wings* similar to those of *C. nigripennis*,

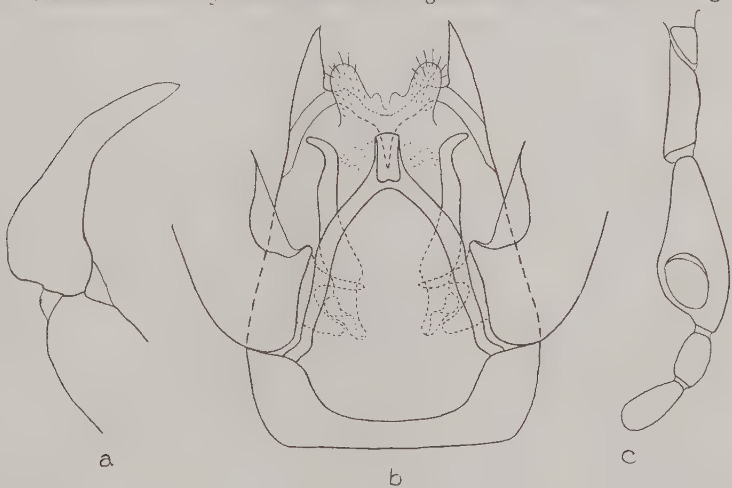


Fig. 1. *Culicoides lamborni*, sp.n. ♂, outlines of: *a*, clasper; *b*, part of hypopygium, ventral view; *c*, palp. × c. 200.

but the pale spots rather larger; the pale spot covering the cross-vein reaching to the costa and enveloping the proximal half of the first radial cell and the base of the petiole of the fourth vein, the pale spot at the end of the costa just covering the junction of the third vein with the costa and the pale area at the base of the wing rather more distinct. Halteres brown. *Legs* darkish brown, tarsi somewhat paler brown than the femora and tibiae; with narrow pale bands on the basal parts

* The unit referred to is approximately 3·7 μ.

of the tibiae just below the knees, and on the fore and middle legs indications of similar pale bands on the femora just above the knees. *Abdomen* darkish brown, especially dorsally, rather sparsely clothed with hairs. *Hypopygium* (fig. 1, *a*, *b*) dark brown, somewhat resembling that of *C. eriodendroni*, C.I. & M. Ninth segment: tergite moderately hairy, its posterior margin cleft in the middle line, and bearing laterally long, rather stout, and highly chitinised, conical processes, which bear at their tips minute hairs; sternite deeply and widely excavated in the middle line posteriorly, without hairs. Forceps: side-pieces rather long and narrow, the inner side near the base somewhat feebly chitinised, well clothed with hairs, which, however, are rather short; claspers much dilated at the base and bearing on this part numerous large hairs, resembling the claspers of *C. eriodendroni*, but with the transition from the dilated basal part to the narrower distal part less abrupt. Harpes highly chitinised, stout, the distal ends slightly curved and ending bluntly, but not cleek-like as in *C. eriodendroni*. Aedoeagus with a very short, highly chitinised stem which at its extremity is bent slightly ventrally, and long, rather slender but highly chitinised limbs. The ventral wall is not chitinised, and the membrane joining it to the ninth sternite is not spiculated.

Pupa.—Length 3 mm., rather dark coloured and highly chitinised. *Respiratory trumpets*: length about 0·3 mm.; stalk or pedicle moderately long. The trumpets are almost completely clothed with spines and are infuscated at their ends, and bear two or three small knob-like processes. The main tracheal trunk terminates in a fan-like arrangement of about 12 short blunt processes. *Cephalo-thorax*: anterior marginal tubercle large, conical, armature of bristles unfortunately missing; anterior dorsal large, conical, armature missing; dorso-lateral large, bearing a long hair and a short spine; ventro-lateral bearing two hairs; ventro-median small, bearing a long, rather stout hair, and a short, delicate hair. Dorsal tubercles: anterior single, bearing a long bristle; posterior and lateral bearing similar long bristles. Behind the posterior tubercle is a minute tubercle, scarcely more than a socket mark, bearing a minute spine, and in front of the anterior tubercle is a rather large, unarmed tubercle. Postero-dorsal tubercle bearing a long hair. *Abdomen*: anal segment with squamous spines almost to the tips of the processes, which are rather short and black at their ends. Tubercles on the abdominal segments well developed, dark. Dorsal tubercles: antero-submarginal, the inner bearing a moderately long bristle, and the outer a long bristle; postero-marginal, the outermost bearing a moderately long bristle, the next a short spine, the innermost a minute spine, and the other two either apparently unarmed or bearing very small delicate spines. Lateral tubercles rather large, antero-submarginal bearing a short stout spine; postero-marginal, the middle one bearing a long bristle, and the other two short, stout spines. Ventral tubercles: the outer bearing a rather short bristle, the middle one a long bristle or hair, and the inner one a short, stout spine.

Nyasaland: Fort Johnston, 4 and 5.xii.1923, 2 ♂♂, one with pupal pelt attached (*Dr. W. A. Lamborn*).

This insect might be regarded as the male of *C. nigripennis*, C.I. & M., a West African species of which only the female is known, but for the fact that the pupae are quite distinct; it also resembles *C. eriodendroni*, C.I. & M., in some respects, notably in the general configuration of the hypopygium, but is a larger and darker species, and shows differences in a number of characters both of the adult and the pupa.

Culicoides pycnostictus, sp. n.

Length of body (one male and one female), 1·4 and 1·6 mm.; length of wing, 1·3 and 1·4 mm.; greatest breadth of wing, 0·4 and 0·6 mm.—the larger measurements in each case being those of the female. A dark brown midge with profusely spotted wings, closely resembling *C. distinctipennis*, Aust.

Head dark brown. Eyes bare, narrowly separated above in the female, more broadly in the male. Clypeus and proboscis dark brown. Mouth-parts in the female highly chitinised and of the usual form. Palpi dark brown; third segment in the female longer than the fourth and fifth together, inflated distally, and furnished with a very large and deep sensory pit, in the male not so greatly inflated and with a small sensory pit. *Antennae* darkish brown, the torus, and the last five segments in the female, and the last three in the male, being darker brown than the other segments. In the female segments 4 to 10 ovoid, measuring from about 10 by 9 units to 12 by 7 units; segments 11 to 15 more elongated, 11 to 14 sub-equal, about 20 by 7 units, the last segment rather longer, about 25 units, slightly broader, tapering distally to a conical extremity. The combined length of segments 11 to 15 (106 units) greater than that of segments 4 to 10 (74 units), or 3 to 10 (90 units). In the male the plumes dark brown; segments 13 to 15 sub-equal, or the thirteenth a little the longer, three or four times as long as broad. *Thorax* dark brown, the

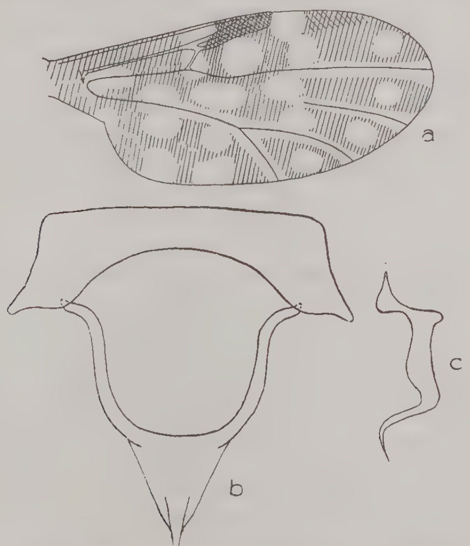


Fig. 2. *Culicoides pycnostictus*, sp.n.: *a*, diagram of wing of ♀; *b*, aedoeagus and **ninth sternite,** ventral view; *c*, harpe, ventral view. ($a \times$ c. 40, b and $c \times$ c. 400.)

adornment indistinguishable in the specimens examined, which had been mounted in balsam. Pleurae darkish brown. Scutellum dark brown, bearing in both sexes two lateral and two centro-marginal bristles, and about 12 to 15 small hairs. Post-scutellum dark brown, but with a small semicircular paler patch on each side of the middle line at the base, and with a pit-like excavation posteriorly. *Wings* (fig. 2, *a*) grey, rather darker along the anterior border than elsewhere, with numerous pale spots and patches; densely clothed with macrotrichia. The adornment is similar to that in *C. distinctipennis*, but the pale spot just beyond the costa is larger and extends backwards and towards the wing tip to reach the anterior ramus of the fourth vein. It is constricted in the middle and is thus incompletely divided into two approximately equal parts, but there is no small distal, pale spot as in *C. praetermissus*. The distal ends of the rami of the fourth and fifth veins are bounded on each side by longitudinal pale bands, and the fork of the fifth vein lies in a pale area. Halteres with white knobs. *Legs* brown, with darker knee-spots, and immediately above and below them more or less distinct narrow pale bands. *Abdomen* darkish brown.

Spermatheca single, oval or pyriform, measuring about 78 μ by 52 μ; the commencement of the duct not chitinised. *Hypopygium* dark brown. Ninth segment: tergite moderately hairy, shape similar to that of *C. distinctipennis*, posterior margin rather deeply notched, but lateral finger-like processes more like those of *C. praetermissus*; sternite without hairs, deeply and broadly excavated in the middle line posteriorly. Forceps normal. Harpes with a sharp bend about the middle as shown in the figure (fig. 2, *c*), tapering to fine, almost filiform ends. Aedoeagus in ventral view (fig. 2, *b*) showing a triangular plate of rather dense chitin which tapers distally to a feebly chitinised, bluntly pointed extremity, which is bent somewhat ventrally and is prolonged proximally into two rather narrow and densely chitinised limbs that are everted at their ends, the two limbs forming a wide, rounded arch. The ventral wall of the aedoeagus is not chitinised, and the membrane joining it to the ninth sternite is not spiculated.

PUPA.—Length about 2 mm.; cephalo-thorax rather dark brown dorsally and anteriorly. *Respiratory trumpets* not very broad, of almost uniform diameter, short, length about 0·25 mm., infuscated deeply at their ends and slightly at their bases, bearing one or two small knob-like processes on the basal part. Main tracheal trunk terminating distally in a few (about 5) short, blunt processes. *Cephalothorax*: anterior marginal tubercle large, bearing a large, strong spine; anterior dorsal bearing a large, strong spine and a very small spine; dorso-lateral bearing a short bristle and a minute spine; ventro-lateral small, bearing a hair and a spine; ventro-median very small or almost obsolete, bearing a hair and a very small spine. Dorsal tubercles: anterior double, the two parts separated, the one anterior to the other, each bearing a short, stout spine; posterior bearing a minute spine; lateral bearing a short hair. Postero-dorsal tubercle bearing a hair. *Abdomen*: anal segment with sharply pointed, divergent processes which are not very long and are dark at their tips. Tubercles on the abdominal segments rather poorly developed. Dorsal tubercles: antero-submarginal, the inner bearing a short spine, and the outer a longer bristle; postero-marginal, the outermost bearing a small bristle, the next a short spine, the innermost a minute spine, and the other two apparently unarmed. Lateral tubercles rather small; antero-submarginal bearing a short spine; postero-marginal, the middle one bearing a hair, and the other two short, stout spines. Ventral tubercles: the outer bearing a short spine, the middle one a short, delicate bristle, and the inner one a minute spine.

NYASALAND: Fort Johnston, 4.xii.1923, 2 ♀♀ and 1 ♂ (*Dr. W. A. Lamborn*). The pupal pelts of one of the females and of the male were also preserved.

This insect resembles in some respects *C. distinctipennis*, Aust., and *C. praetermissus*, C.I. & M., but may be distinguished from them by the details of the adornment of the wings, and by the characters of the spermatheca of the female, and the hypopygium of the male.

Dasyhelea nyasae, sp. n.

Length of body, 2·1 mm.; length of wing, 1·5 to 1·6 mm., greatest breadth of wing, 0·5 to 0·6 mm. In the male the wings are longer and narrower than in the female. A very dark brown, almost black, species; the female resembling *D. bolei*, and the male *D. nigrofusca*.

Head very dark brown, almost black. Eyes densely hairy; broadly contiguous above in both sexes, the facets, however, separated by a narrow line. Clypeus and proboscis very dark brown; the latter quite short. Palpi dark brown; in both sexes the second segment short and rather broad, third the longest, about one and a half times the length of the fourth, cylindrical, not inflated, without a sensory pit, but bearing on its inner aspect a number of long sensory hairs shaped like drumsticks, fifth a little longer than the fourth, somewhat dilated at its end. *Antennae*: in the female dark brown, torus almost black; bearing short, dark brown hairs,

and both long and short spines on all the flagellum segments ; all the flagellum segments are also finely sculptured ; segments 4 to 14 forming a continuous series, from oval to flask-shaped, their lengths and greatest breadths ranging from 15 by 12 units to 19 by 9 units ; the fifteenth segment longer and broader, about 31 by 10 units, tapering distally and ending in a stylet (about 5 units long). In the male dark brown, with an almost black plume, finely sculptured ; segments 4 to 11 gradually diminishing in size, in one specimen from about 14 by 14 units to about 14 by 10 units ; segments 12 to 14 elongated, binodose, lengths in the same specimen about 33, 27 and 23 units respectively ; the last segment rather longer, about 30

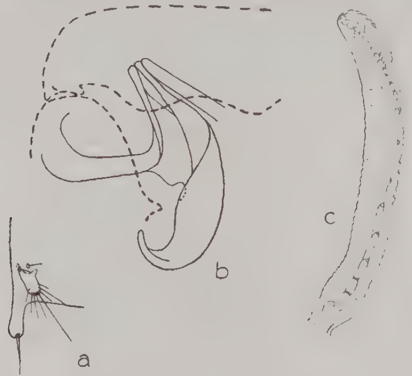


Fig. 3. *Dasyhelea nyasae*, sp.n., ♂ : *a*, lateral processes at posterior extremity of ninth tergite, ventral view ; *b*, portions of harpes, ventral view ; *c*, respiratory trumpet of pupa.

units, broader, not binodose, tapering distally and ending in a stylet (about 6 units long). *Thorax* very dark brown, almost black, the adornment, if any, indistinguishable in the specimens examined, which had been mounted in balsam. Pleurae very dark brown. Scutellum yellowish at the sides, dark brown in the middle ; bearing a transverse row of about ten bristles, and about seven to ten smaller hairs. Postscutellum very dark brown. *Wings* slightly infuscated at the junction of the first and third veins with the costa ; in the female densely clothed with macrotrichia which extend to the base between the fourth and fifth veins, in the male more sparsely hairy. Third vein joining the costa slightly beyond the middle of the wing (♀ 48 : 80, ♂ 50 : 89) and distal to the level of the point of bifurcation of the fifth vein (♀ 39 : 80, ♂ 44 : 89). First and third veins fused proximally, but forming a small distal cell which, however, is rather ill defined. Halteres with brownish knobs. *Legs* : femora and tibiae yellowish brown, with darker brown median bands, dark knee-spots, and more or less infuscation at the bases of the femora and the apices of the tibiae. First four tarsal segments pale brown, almost colourless, the last segment, however, entirely blackish in the female, but not so dark in the male. Claws not strongly curved, small, simple, equal ; in the male, however, with bifid ends. *Abdomen* dark brown, well clothed with hairs ; in the female with a darker brown marking, shaped somewhat like the head of a spear, just anterior to the vulval orifice. Spermatheca single, well chitinised, resembling that of *D. retorta* ; diameter of the spherical portion about 70 μ, length of the proximal portion about 37 μ, and greatest width about 18 μ. *Hypopygium* very dark brown, closely resembling that of *D. nigrofusca*, but differing in the following details : ninth segment with longer lateral processes on the posterior border of the tergite, much longer than the hairy process which lies ventrally at their base (fig. 3, *a*), and with the sternite notched in the middle line posteriorly (fig. 3, *b*) ; unpaired process of the harpes larger (fig. 3, *b*), not serrated at its extremity ; and membrane joining the aedoeagus to the ninth sternite spiculated at its base.

PUPA.—Length about 2·6 mm. Integument dark brown and coarsely shagreened. *Respiratory trumpets* (fig. 3. *c*) rather long, about 0·4 mm., cylindrical, somewhat expanded towards their distal ends. The main tracheal trunk giving off short lateral branches (about eight) at rather wide intervals throughout the basal two-thirds of the trumpets, and then a fan-like cluster of about 25 short, terminal processes. *Cephalothorax* : operculum very dark and coarsely spiculated, bearing six tubercles. Anterior marginal tubercle large, dark, spiculated coarsely, apparently unarmed. Other cephalothoracic tubercles small and either unarmed or bearing only small hairs or spines. Dorsal region dark and raised into numerous infuscated humps ; the tubercles represented only by one or two small spines. *Abdomen* with rather poorly developed tubercles, obsolete on the basal segments, which are either unarmed, or bear very small spines. Terminal segment with flange-like dorsal and lateral processes, and on each side a conical process bearing at its end a short, stout spine.

NYASALAND : Fort Johnston, 3–5.xii.1923, 1 ♀ and 4 ♂♂ (*Dr. W. A. Lamborn*). The pupal pelt of one of the males was preserved with the adult insect.

The female of this species resembles rather closely *D. bolei*, I. & M., only the female of which is known, but may be distinguished by a number of characters, such as the lengths of the terminal segments of the antenna and the size of the spermatheca. The male similarly resembles rather closely *D. nigrofusca*, C.I. & M., of which only the male is known, and has somewhat similar genitalia, which, however, differ in detail as described above. The pupa of *D. nigrofusca*, which has been briefly described, differs from that of the species here described, notably in the form of the respiratory trumpets.

DESCRIPTIONS OF TWO NEW SPECIES OF THE GENUS METADREPANA (DREPANIDAE, LEP.).

By W. H. T. Tams.

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Some time ago Mr. T. J. Anderson, Government Entomologist, Kenya Colony, sent to the Imperial Bureau of Entomology several specimens of a Drepanid moth, the larvae of which were defoliating coffee during 1922. The moth, which is described below, proved to be a new one, and I have described at the same time another species from Northern Nigeria, and have given figures of the male genitalia of both species, and of the wing venation (fig. 1) and male genitalia (fig. 2) of the genotype, *Metadrepana glauca*, Hmpsn.

Metadrepana andersoni, Tams, **sp. n.**

♂. Palpi fuscous irrorated with clay-colour. Antennae light drab. Frons olive-brown. Patagia (collar-tippets) whitish anteriorly, tinged with vinaceous posteriorly; thorax avellaneous; abdomen light buff dorsally and ventrally; pectus drab anteriorly, light buff laterally. Legs light buff, shaded with drab, the fore tibiae and tarsi shaded with fuscous. Wings glossy; fore wings vinaceous-cinnamon, suffused with brownish-vinaceous, except the area between oblique line and termen; some obscure patchy traces of olive-buff; an obscure shade irrorated with madder-brown across the cell above the base of vein *Cu*2; a few black scales above the

Fig. 1. *Metadrepana glauca*, Hmpsn., wing venation.

Fig. 2. Male genitalia of *Metadrepana glauca*, Hmpsn.

base of and below vein *M*1, in the position of the obsolescent postmedial line, of which there are further traces near the inner margin in the shape of a few black scales above and below the anal vein; an obscure oblique citrine-drab line from just before the wing-apex, apparently directed towards the middle of the inner margin, but extending only to vein *Cu*1; traces of a citrine-drab subterminal line, in the shape of two black-irrorated spots between veins *M*3–*Cu*1, and *Cu*1–*Cu*2; some scattered black scales between these and termen, and extending down to tornus; a few scattered black scales at wing-apex; terminal line flesh-ochre; fringe clove-brown;

hind wing coloration like that of fore wing, but towards the termen the wing appears somewhat darker owing to an admixture of greyish-olive ; above the middle of the cell, from the base to just beyond the cell-end, a cartridge-buff area along the costa ; an almost straight, pale, postmedial line from apex to inner margin, which it meets at right angles just below the middle ; between postmedial and termen scattered black irroration ; terminal line and fringe as in fore wing. Underside coloured like upper side ; inner margin of fore wing pale like upper side costal area of hind wing ; a black spot at middle of discocellulars ; the citrine-drab line from near the apex more distinct than on upper side, and extending further towards inner margin, in its lower part showing a tendency to run parallel with the termen ; the whole wing, except costa and upper margin of cell, sparsely irrorated with black ; area between oblique line and termen not lighter than rest of wing, but somewhat darker owing to an admixture of greyish-olive ; terminal line not flesh-ochre as on upper side, but like ground-colour ; fringe with a basal row of scales of ground-colour ; hind wings like fore wings, but with a more pronounced spot at end of cell. Expanse 34–38 mm. (32–35 mm. from tip to tip). One ♂ smaller and paler than the holotype ♂, and in two others the greyish-olive colour distinctly predominating. The small ♂ possesses also in the hind wing between veins *M*2–*M*3 and *M*3–*Cu*1 two black subterminal spots like those in the fore wing.

Fig. 3. Male genitalia of *Metadrepana andersoni*, sp.n.

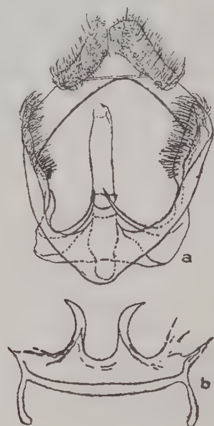

Fig. 4. *Metadrepana pallida*, sp.n. : *a*, male genitalia ; *b*, 8th sternite.

♀. Ground-colour as in ♂, but area from base to oblique line suffused with testaceous ; on the costa before the oblique line a large fuscous wedge-shaped dash with apex basad, preceded by a whitish roughly wedge-shaped dash with apex terminad, this again preceded by a smaller fuscous spot ; oblique line sharply curved (convexity terminad) from costa to vein *M*1, slightly curved (convexity basad) from *M*1 to inner margin ; two olive-brown subterminal spots between veins *M*3–*Cu*1 and *Cu*1–*Cu*2, the latter smaller ; hind wing coloration like that of fore wing, but with costal margin pale as in ♂ ; postmedial line more distinct, accentuated by dark shading basad, gently curved from apex to vein *M*3 (convexity terminad), and again from *M*3 to inner margin (but convexity basad) ; an olive-brown subterminal wedge-shaped spot (apex terminad) between veins *M*3 and *Cu*1 ; no black irroration. Underside as in ♂, but with less black irroration, no greyish-olive suffusion, and with the oblique line more prominent. Expanse 34–40 mm. (30–35 mm. from tip to tip). Four paratype ♀♀ are strongly suffused with dark colour

varying from vinaceous-brown to chocolate, whilst their undersides are even more strongly irrorated with black than those of the ♂♂, with some greyish-olive suffusion.

Holotype ♂ and 3 paratype ♂♂, allotype ♀ and 4 paratype ♀♀, Kenya Colony (*T. J. Anderson*).

The holotype and allotype, with five paratypes (2 ♂♂ and 3 ♀♀) have been presented, through the generosity of Mr. T. J. Anderson and the Director of the Imperial Bureau of Entomology, to the British Museum. The species is apparently variable a one.

Metadrepana pallida, Tams, **sp. n.**

♂. General coloration above: a pale shade of tawny-olive; palpi and frons olive-brown; scattered olive-brown, clove-brown and blackish-brown irrorations, most abundant between end of cell and termen, and along inner margin, in both wings, and in the hind wing forming a small blackish-brown spot at end of cell, and a larger one about the middle of and between veins *M*3 and *Cu*1; fore wing with an oblique line from just before apex, sharply curved between costa and vein *M*1 (convexity terminad), less sharply curved between veins *M*1–*Cu*2 (convexity basad), curved with convexity terminad, between vein *Cu*2 and inner margin, which it meets at about three-quarters from the wing-base; hind wing with area between middle of cell and costa, and from base to half-way between end of cell and termen, ivory-yellow, with very little irroration. Fore legs olive-brown dorsally. Underside of both wings cream-buff; fore wings below anal fold ivory-yellow; scattered olive-brown irroration, forming a small spot at middle of discocellulars, a strong dash between lower margin of cell and anal fold just before base of vein *Cu*2, and a number of subterminal striae, principally at the tornus; oblique line as on upper side, well marked, but not extending below anal fold: hind wings with sparse olive-brown irroration on costa and subterminally, and with a small olive-brown spot at middle of discocellulars. Expanse 34 mm. (32 mm. from tip to tip).

Holotype ♂: N. Nigeria (*E. C. T. Clouston*).

(Colours from Ridgway's "Color Standards and Color Nomenclature," 1912.)

It will be noticed that the general structure of the ♂ genitalia in the three very distinct species, *M. glauca* (fig. 2), *M. andersoni* (fig. 3), and *M. pallida* (fig. 4), is essentially the same. In the case of *M. pallida*, the 8th abdominal sternite has been separated from the organs proper, of which the 9th segment, tergite and sternite, forms a part. In these moths, as in others in other families, the 8th sternite shows considerable modification, and often itself provides a good specific character.

R A NEW PROCESSIONARY MOTH (NOTODONTIDAE) INJURIOUS TO PINE TREES IN CYPRUS.

By W. H. T. Tams.

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The interesting moth described below was bred from larvae which were causing serious damage to pine trees in Cyprus, by the Entomologist to the Department of Agriculture in Cyprus, Mr. D. S. Wilkinson, who has presented to the British Museum (Natural History), through the Imperial Bureau of Entomology, the two males which he bred.

Thaumetopoea wilkinsoni, Tams, sp. n.

♂. Palpi grey with some blackish hairs. Antennae pale honey-yellow. Frons cream-buff mixed with fuscous. Vertex of head cream-buff. Thorax grey, with some cream-buff hair at the bases of the wings. Abdomen Dresden brown, the anterior and posterior edges of the segments lighter, the last three segments shaded with fuscous. Pectus grey mixed with light buff, some fuscous beneath the head. Underside of abdomen light buff. Legs light buff mixed with some greyish and fuscous. Fore wing (fig. 1) grey (dark neutral grey irrorated with white), the pattern

Fig. 1. *Thaumetopoea wilkinsoni*, sp.n.

delicately picked out with black; a black basal line forming a V (on its side, with apex basad) in the cell, then running more or less straight to inner margin, at right angles to the anal vein; an obscure antemedial line, commencing as a black spot on the costa, then broad and diffuse, curving through the cell roughly parallel to the discocellulars, then curving (concavity basad) to the anal vein, thence forming an oblique black dash on the inner margin; a long, angled, black discocellular mark; a black postmedial line forming three distinct dentations from costa to vein *M*1, then almost straight (except for interneural curves) to near the middle of vein *Cu*1, curving sharply inward (convexity basad) and recurving towards the tornus; the dentations on veins *M*3, *Cu*1 and *A*2 accentuated with black; a large black wedge-shaped dash on the costa, subterminally; area between postmedial and termen with some diffuse whitish patches, in part accentuating the postmedial line; terminal edging and fringe sooty-black, with whitish dashes at the ends of the veins. Hind wing white; termen and base of fringe fuscous; a distinct fuscous-black spot on termen and fringe between vein *Cu*2 and anal fold. Underside of fore wing with basal two-thirds, except on costa, whitish, remainder greyish; a fuscous-black spot on costa beyond upper angle of cell; underside of hind wing like upper side. Expanse 33–35 mm. (tip to tip of fore wings).

♀. Like ♂, but with slight brownish tinge. Wing markings less pronounced. Underside of fore wing with long, drab hairs in the cell and at base of wing below the cell. Anal tuft composed of large, broad, rounded fuscous scales. Expanse 45 mm. (tip to tip of fore wings).

Holotype ♂ and paratype ♂: Cyprus, 27.ix.1924, bred from pine (*Wilkinson*).

Allotype ♀: Mountains of Cyprus (*D. M. A. Bate*).

Paratypes: 7 ♂♂, Platres, Cyprus, 5,000–6,000 feet, 16.ix.–16.x.1920; 1 ♂, Platres, 23.vii.1921; 1 ♀, Platres, ix.1921.

The nine paratypes from Platres were all taken by Captain K. J. Hayward, who made extensive collections in Cyprus in 1920 and 1921.

Fig. 2. Male genitalia of: (*a*) *Thaumetopoea pityocampa*, Schiff.; (*b*) *T. pinivora*, Treit.; (*c*) *T. wilkinsoni*, sp.n.

The figures of the male genitalia (fig. 2, one valve only shown), and of the scales from the anal tufts of the females of the three species *Thaumetopoea pityocampa*, Schiff., *T. pinivora*, Treit., and *T. wilkinsoni* show interesting differences. A cursory examination of the anal tufts of a number of well-known species reveals the fact that each species possesses a type of scale peculiar to itself. I have chosen for comparison two of the best known species of the genus, *T. pityocampa*, Schiff., and *T. pinivora*, Treit., because the new species here described resembles in some characters *T. pityocampa* and in others *T. pinivora*.

Fig. 3. Scales from the anal tuft of females of: (*a*) *Thaumetopoea wilkinsoni*, sp.n.; (*b*) *T. pityocampa*, Schiff.; (*c*) *T. pinivora*, Treit.

The genus *Thaumetopoea* is one possessing many interesting features. The habits of the larvae will well repay investigation, for they vary with the different species, particularly in the number of larvae which travel abreast. I should like to make the suggestion that not only should any student who has the opportunity to observe these remarkable insects rear the adults, but he should preserve examples of the larvae and pupae, and in addition carefully photograph the larvae in procession.

THE EARLY STAGES OF SAMOAN MOSQUITOS.

By P. A. Buxton, M.R.C.S., L.R.C.P., D.T.M. & H.,
and
G. H. E. Hopkins, B.A., F.E.S.
(*Expedition of the London School of Tropical Medicine to Samoa.*)

Most of the early stages described below were previously unknown, and as *Aëdes variegatus*, Dol. (*Stegomyia pseudoscutellaris*, Theo.) is of great importance in preventive medicine, it seems best to publish these notes and figures at once.

Specimens of all our species have been submitted to Lt.-Col. A. Alcock, F.R.S., and Mr. F. W. Edwards. The synonymy used is that of Edwards (1924). All our material is from Apia, Upolu Island, where we have obtained large numbers of eggs, larvae, and pupae of all species known to occur here, except *Culex samoaënsis*, Theo. (*Pseudotaeniorhynchus samoaensis*) and *Aëdes* (*Aëdimorphus*) *vexans*, Mg. (*Ochlerotatus vexans*). The early stages of the first are unknown; those of the second have never been found in Samoa. The other five species can be identified with certainty in every stage (except the pupae, and possibly the eggs, of *Culex fatigans* and *C. annulirostris*).

The figures have been drawn with a camera lucida, and are our joint work. They are based, in every case, on a series of specimens, identification being by the isolation method. Only fourth-stage larvae were studied.

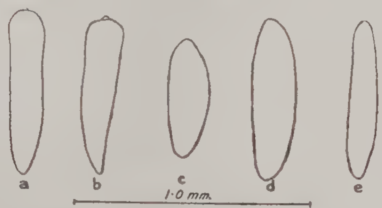

Fig. 1. Eggs of Samoan Culicines: (*a*) *Culex fatigans*, Wd.; (*b*) *C. annulirostris*, Skuse; (*c*) *Aëdes variegatus*, Dol.; (*d*) *A. argenteus*, Poiret; (*e*) *A. kochi*, Dön.

Eggs.

The eggs of *Culex fatigans*, Wied., and *C. annulirostris*, Skuse, are brown and laid in rafts; those of *Aëdes argenteus*, Poir. (*Stegomyia fasciata*, F.), *A. variegatus*, and *A.* (*Finlaya*) *kochi*, Dön. (*F. samoana*, Grünb.), are black and laid singly.

The eggs of *Culex fatigans* and *C. annulirostris* are very similar but can be distinguished with difficulty; those of *C. fatigans* being less regular and nearly cylindrical, while those of *C. annulirostris* are more regular and taper from a point quite close to the micropylar end (fig. 1).

The eggs of the three species of *Aëdes* are easily distinguished, even with the naked eye, by their relative length and breadth, that of *A. variegatus* being stouter, and that of *A. kochi* slimmer than that of *A. argenteus* (fig. 1). The following table gives dimensions in millimetres taken from ten eggs of each species.

	A. variegatus.			*A. argenteus.*			*A. kochi.*		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Length ...	0·47	0·49	0·43	0·66	0·70	0·60	0·74	0·79	0·69
Breadth ...	0·15	0·15	0·15	0·17	0·17	0·17	0·13	0·14	0·13

Examination with the low power of a microscope shows that the sculpturing is shallower on the egg of *A. variegatus* than on that of *A. argenteus*; that on the egg of *A. kochi* is shallower still.

Larvae.

Culex annulirostris, Skuse.

This is the species referred to by Bahr and by O'Connor as *C. jepsoni*, Theo. Their material is in the British Museum. According to Edwards (1924), *C. jepsoni* is a synonym of *C. sitiens*, Wied., a species which does not occur in Samoa.

The larva of *C. annulirostris* has been shortly described by Cooling from Australian specimens; as his figure and description do not agree with our material we propose to describe and figure it again. It resembles rather closely that of *C. tipuliformis* (see Edwards, 1922). The larva of *C. annulirostris* may be described as follows:—

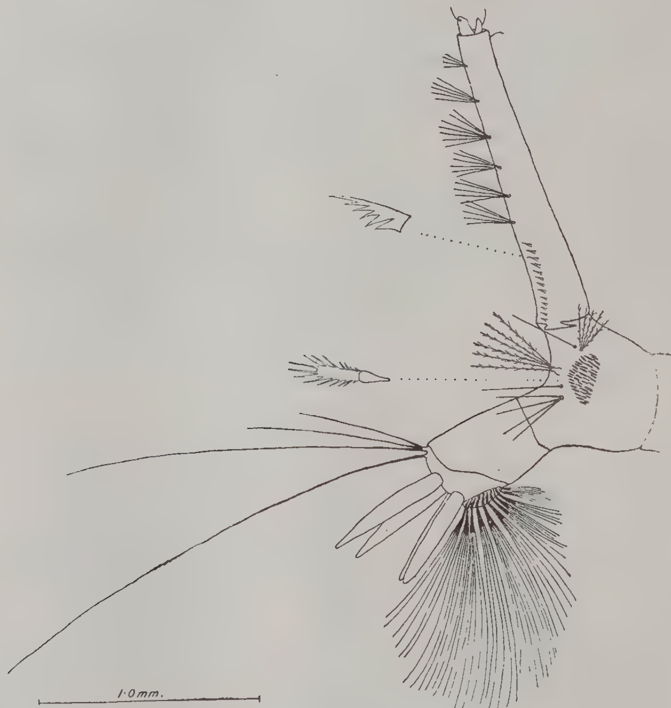

Fig. 2. Terminal segments of fourth stage larva of *Culex annulirostris*, Skuse.

Head.—Preclypeal seta simple, peg-like. Preantennal situated slightly *behind* and internal to base of antenna, 8–10 branches, large and plumose. Postantennal setae represented by a group of three close together; the most anterior and internal of these (presumably the inner postantennal seta) simple, fine and long: the other two (presumably middle and outer postantennal) with 3–5 conspicuous long plumose branches. Mental plate with one large median tooth and six or seven subequal teeth on each side. Basal part of antenna pale, beset dorsally with small spines, a large tuft of about forty plumose branches at three-fourths. The shaft beyond this point brown. Two long, stout setae at eleven-twelfths. Terminally a long spine, a short spine, and a short, blunt process. *Thorax.*—There are no features which call for remark. *Abdomen.*—The first seven segments are not in any way remarkable. Eighth segment with a comb of about fifty scales arranged in a

semicircular area. Fringe of comb-scales long and dense (fig. 2). Siphon pale brown, widest at base, with straight sides, ratio of length to breadth about 5 : 1. Acus conspicuous (omitted by Cooling). Eleven or twelve subventral hair-tufts irregularly arranged so as not to form definite pairs. First hair-tuft at three-eighths, last at three-fourths. Each tuft consists of 6–10 simple branches, longer in the basal than in the distal tufts. Pecten teeth 12–15, similar to one another, extending from base of siphon to just beyond one-fourth, that is to say, not overlapping with the ventral hair-tufts. Each tooth with about six denticles, which are distributed along its entire length (fig. 2). Ninth apparent segment well chitinized, the dorsal plate extending right down to the ventral surface of the segment. Dorsal terminal setae few (about four on each side) stiff and simple. Ventral fin well developed, consisting of about twelve primary members, each dividing close to the base into a large number of branches which are not plumose. Anal gills equal in size, lanceolate.

It is possible that *C. sitiens*, Wied., may be found in Samoa. According to Cooling, the larva is similar to that of *C. annulirostris*, but has short round anal gills.

Culex fatigans, Wied.

The larva of this species is too well known to require description. It may be distinguished from that of *C. annulirostris* by the shape of the siphon ; that of *C. fatigans* is shorter and wider (length about 1·0 mm. ; length : basal breadth, about 3·5 : 1), and the sides are slightly convex ; that of *C. annulirostris* longer and narrower (length about 1·4 mm. ; length : breadth, about 5 : 1), and with straight sides. There are numerous other differences which are less readily observed.

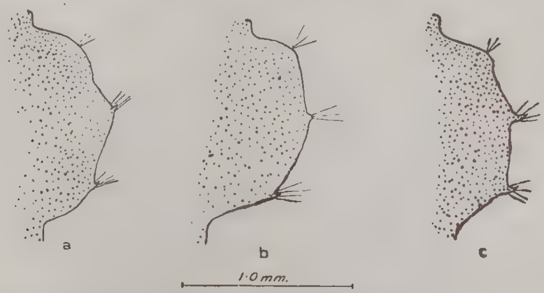

Fig. 3. Outline of thorax, seen from below, of fourth-stage larva of : (*a, b*) *Aëdes variegatus*, Dol. ; (*c*) *A. argenteus*, Poir. ; bases only of setae are shown.

The larvae of *Aëdes argenteus* and *A. variegatus* are very similar in general appearance. As that of *A. argenteus* has been described and figured in detail (Macfie, 1916), we have only found it necessary to describe the points of difference between the two species.

Head.—Antennae, mental plate and chaetotaxy appear to be similar. *Thorax.*—On the ventro-lateral margin of the thorax of both species there are three large tufts of setae. In *A. argenteus* immediately behind the base of each of the two posterior tufts is a conspicuous, highly chitinized, thorn-like process (fig. 3, *c*). In *A. variegatus* these processes are small, inconspicuous and only slightly chitinized; the posterior pair is frequently absent (fig. 3, *a, b*). *Abdomen.*—The lateral barbs of the comb scales of *A. variegatus* (fig. 4) are distinctly smaller and more delicate than those of *A. argenteus.* The siphons of the two species do not differ appreciably in proportion, chaetotaxy, or in the pecten teeth. The two pairs of anal gills of the larva of *A. argenteus* are of equal size ; in *A. variegatus* the gills of the dorsal

pair are one-third larger than those of the ventral. It is easy to separate the larvae of the two species by observing these structures with a hand-lens, and the character is still easily perceptible in larvae that have been preserved in alcohol.

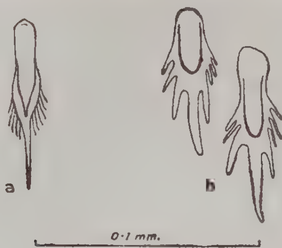

Fig. 4. Comb scales of fourth-stage larva of: (*a*) *Aëdes variegatus*, Dol.; (*b*) *A. argenteus*, Poiret.

The larva of *Aëdes* (*Finlaya*) *kochi* may be distinguished at once from those of *A. argenteus* and *A. variegatus* by its pale siphon, and from those of *Culex fatigans* and *C. annulirostris* by its short antennae and siphon. A brief description follows: *Head*.—Pale brown, narrower than thorax. Mouth-brushes not conspicuous (omitted from fig. 5). Setae of head small and weak. Preclypeal hair massive and short, with 2-3 terminal branches. Preantennal 2- (or sometimes 3-) branched, middle postantennal similar, outer postantennal with half a dozen branches; the preantennal, middle and outer postantennal in one curve, convex forwards (*cf.* Lang, fig. 9, p. 15); the inner postantennal long and simple, placed almost directly

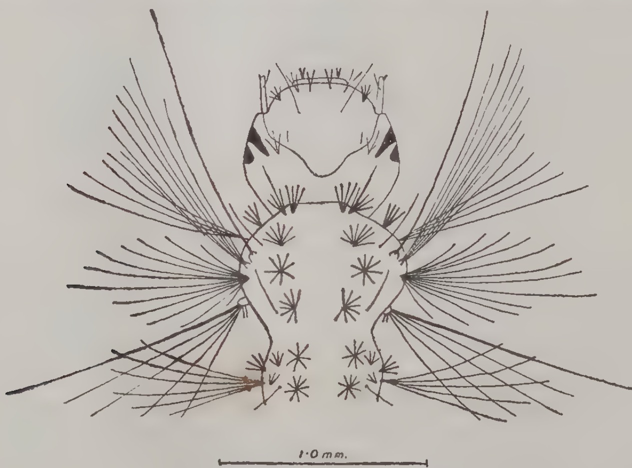

Fig. 5. Head and thorax of fourth-stage larva of *Aëdes kochi*, Dön.; mouth-brushes and pectination of macrochaetae omitted.

behind the middle postantennal hair. Vertical hair minute, trans-sutural with three long, very fine branches, difficult to see. Antenna straight and nearly cylindrical, uniform pale brown; shaft hair at three-fourths, long and simple. There is a subterminal seta on the ventral side, three terminal spines, and a spatulate process (fig. 6) referred to by O'Connor as a "pad or sucker." Mental plate not remarkable, with about eleven teeth on each side, diminishing gradually from the middle line. *Thorax*.—Dorsal surface beset with numerous setae, each of which divides at the base into many stiff, short, equal branches forming a rosette. Ventral surface

bearing four similar setae. Lateral tufts consisting of macrochaetae, many of them subplumose (the feathering is omitted from fig. 5), and longer than the width of the thorax. Subventral, thorn-like processes (such as are found in *Aëdes argenteus*) are absent. *Abdomen.*—Dorsum bearing many rosette setae, such as have been described on the thorax. Lateral tufts of segments 1-6 long, and composed of many branches. Comb of eighth segment a semilunar patch of about sixty teeth, the more anterior minute and triangular, the posterior ones long, spatulate, and with an exceedingly fine, short fringe. Siphon slightly chitinized, without acus, straight-sided, and widest just beyond base. Pecten teeth, ten in number, simple, acuminate ;

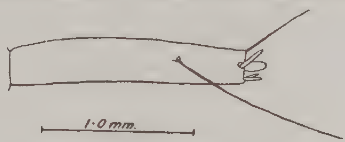

Fig. 6. Dorsal view of left antenna of fourth-stage larva of *Aëdes kochi*, Dön.

the distal two or three slightly more widely spaced than the basal ones. Siphonal hair arising a little distal to last tooth of pecten, dividing at base into two or three pectinate branches. Anal segment with a weakly chitinized dorsal plate which covers about half the segment as seen from the side. Posterodorsally, a tuft of long stiff setae, and beneath it a compact body of perhaps fifty spines, from the middle of which arises a long stiff seta with three or four basal branches. Ventral fin consisting of about half a dozen primary members. Anal gills pointed, the dorsal pair longer than the ventral (fig. 7).

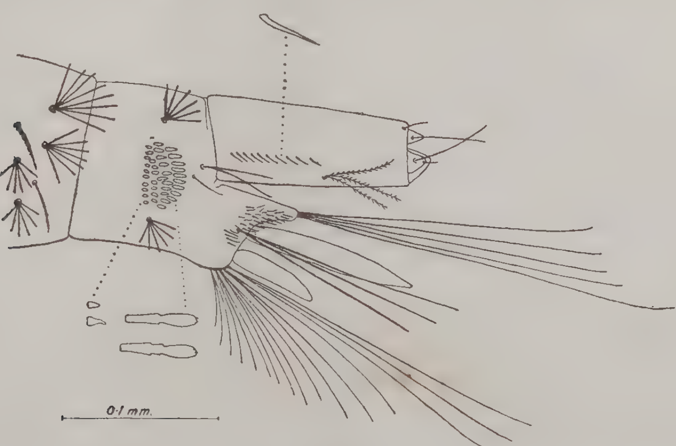

Fig. 7. Terminal segments of fourth-stage larva of *Aëdes kochi*, Dön.

It has not been possible here in Samoa to search the literature for descriptions of other *Finlaya* larvae, but descriptions of ten are available (Barraud, 6 species ; Macfie & Ingram, 1923, 2 ; Lang, 1 ; Cooling, 1). Barraud has specified the "general characters of the known Indian species," but his points nearly all break down when applied to species not found in India. For instance, in *A.* (*F.*) *kochi* there is no acus, and the pecten spines and siphonal tufts are simple. In the African *F. wellmani*, Theo., and *F. longipalpis*, Grünb. (see Macfie & Ingram, 1923) the acus is apparently absent, and in *F. wellmani* the comb has about eight scales. In the European *F. geniculata*, Oliv. (see Lang), the comb scales, fourteen in number, are

arranged in a single row. The Australian *F. notoscriptus*, Skuse (see Cooling) agrees much better with Barraud's diagnosis of the genus *Finlaya*, but most of the evidence points to the conclusion that there are no characters separating larvae of *Finlaya* from larvae of *Stegomyia* or *Aëdes*. We have, therefore, referred to our species as *Aëdes kochi* throughout this paper. It will be noticed that none of the other described species, to which reference has been made, possess the thick vestiture of rosette setae so characteristic of *A. kochi*, and it is possible that these structures are in some way adaptive to life in the axils of taro (*Colocasia esculenta*).*

Aëdes vexans, Mg. Of this species, which has been recorded with some doubt from Samoa (see Edwards, 1923, p. 372), we have not seen the early stages. The siphon of the larva is figured by Lang (after Dyar, Howard & Knab). It differs from those of any other Samoan species of *Aëdes* in the fact that the two most distal siphon teeth are widely spaced ; in the other species all the siphon teeth are placed close together.

Pupae.

The pupae of our species vary so much in size that we have refrained from giving measurements of the whole or of any of the parts.

Culex fatigans and *C. annulirostris* cannot be distinguished in the pupal stage. As the pupa of *C. fatigans* has been described and figured by Ingram & Macfie (1917) we shall not deal with it. Their figure appears to be slightly inaccurate, as several of the more minute setae have been omitted.

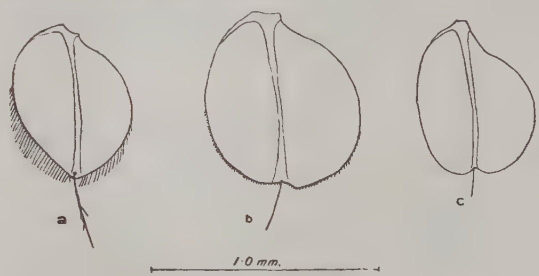

Fig. 8. Left pupal paddle of : (*a*) *Aëdes variegatus*, Dol. ; (*b*) *A. argenteus*, Poiret ; (*c*) *A. kochi*, Dön.

Aëdes argenteus, *A. variegatus* and *A. kochi*. In these species the pupal trumpet is without transverse folds. They may therefore be easily distinguished from the pupae of *Culex* spp. There is apparently no significant difference between the trumpets of these three species, but they may be separated with ease by the paddles (fig. 8). That of *A. argenteus* has a slight fringe, a shallow terminal indentation and a short unbranched terminal seta ; that of *A. variegatus*, a long fringe, no terminal indentation and a long, frequently branched terminal seta ; that of *A. kochi* has a deep terminal indentation, and the fringe (not shown in our figure) is exceedingly short and delicate. Other minor points of difference exist, but hardly merit a figure. Seta B on segments 4, 5, and 6, is as long as the succeeding segment in *A. variegatus*, shorter in *A. argenteus*, and longer in *A. kochi*. Seta A on the 8th segment has 5-7 basal branches in *A. variegatus*, only 2-5 in *A. argenteus*, and about a dozen in *A. kochi* (for the lettering used, see Macfie, 1919).

* It may be noted that rosette setae are equally well developed in *A. echinus*, Edw. (a tree-hole breeder) and in various other tree-hole breeding species belonging to other subgenera and genera. The great development of bristles in all these species is perhaps a biochemical phenomenon connected with the composition of the surrounding medium.—F. W. E.

The following keys may prove useful :—

Larvae.

1. Siphon long ... ... 2.
   Siphon short and broad ... ... 3.
2. Siphonal ratio about 5 : 1 ; about ten siphonal hair-tufts *Culex annulirostris.*
   Ratio about 3·5 : 1 ; four tufts ... ... *C. fatigans.*

ecten

3. Two most distal ~~comb~~ scales widely spaced ... ... *Aëdes vexans.*
   All ~~comb~~ scales close together ... ... 4.
4. Vestiture of stout tufted setae ; patch of about 60 comb scales ; siphon pale ... ... *A. kochi.*
   No such vestiture ; comb scales in one row, not more than about a dozen ; siphon dark ... ... 5.
5. Anal gills equal ; comb scales, see figure 4 ... ... *A. argenteus.*
   Dorsal gills longer than ventral ; comb scales, see figure 4 ... *A. variegatus.*

Pupae.

1. Paddle with two terminal setae ... ... *Culex fatigans* or *C. annulirostris.*
   Paddle with one terminal seta ... ... 2.
2. Paddle without terminal concavity, fringe long ... ... *A. variegatus.*
   Paddle with shallow terminal concavity, fringe short ... ... *A. argenteus.*
   Paddle with deep terminal concavity, fringe very short and delicate *A. kochi.*

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AN ATTEMPT TO CONTROL *GLOSSINA MORSITANS* BY MEANS OF *SYNTOMOSPHYRUM GLOSSINAE*, WATERSTON.

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The attempt to effect the control of insect pests by the introduction of other insects parasitic elsewhere on members of the same or allied genera, and their propagation in the laboratory on their new host until sufficient numbers for field distribution have been obtained, represents a recent and highly important development of Applied Entomological Science. In this connection may be instanced the introduction into Hawaii of parasites destructive to the sugar-cane leafhopper; the introduction of the Scoliid *Tiphia parallela*, Smith, from Barbados into Mauritius for the control of the Melolonthid *Lachnosterna* (*Phytalus*) *smithi*, Arrow, a sugar-cane pest; the importation into the U.S.A. of Chalcid, Tachinid, and other parasites of the gipsy and brown-tail moths; and the recent despatch to New Zealand of Tachinid flies destructive in England to Forficulidae.

As far back as 1914 it was suggested by Major E. E. Austen that a measure of control of *G. morsitans* might possibly be effected by the introduction into a fly area of parasites destructive elsewhere to Muscids, especially the Chalcid *Spalangia*, which was then unrecorded for Africa. The suggestion was nullified, however, by the discovery made by the present writer in 1915 that this parasite already occurs commonly in East Africa, being destructive to various small Muscids of the housefly type in Tanganyika Territory and Nyasaland. In Nyasaland, it does not, so far as can be ascertained, attack *Glossina*, nor has it been recorded as a parasite of this genus in other parts of Africa, although it must almost certainly have a distribution equally as wide as *Glossina*. It is hardly to be expected, therefore, that any attempt to utilise this insect, or indeed various other Chalcids shown by the writer to be destructive to the larger Muscids (particularly *Sarcophaga* species) of Tanganyika Territory and Nyasaland, would meet with success.

The enquiry into the bionomics of *Glossina* by entomologists working in various parts of Tropical Africa—Nigeria, Tanganyika Territory, Portuguese East Africa, Rhodesia and Nyasaland—has resulted in the discovery of various parasites naturally destructive to tsetse-flies, *G. morsitans* in particular, and it has been shown that this species, the dominant form of *Glossina* in Rhodesia and Nyasaland, is attacked in different parts of its range by different species of parasites. In Northern and Southern Rhodesia, for instance, the fly is checked by *Mutilla glossinae*, Turner; in Nyasaland by this Mutillid and a second species, *M. benefactrix*, Turner; in Portuguese East Africa by a third species, *M. auxiliaris*, Turner. Several Chalcid parasites of *G. morsitans* obtained in the Northern Territories of the Gold Coast have not been shown to occur in East Africa; the reverse holds good, and in some areas this species is parasitised to a far greater degree than in others. Indeed, in one particular area known to have been invaded recently by the fly no parasites whatever have yet been obtained by the writer. It is remarkable that *G. palpalis* seems to be almost immune from parasite attack. Such facts naturally led one to consider the possibility of effecting an interchange of parasites from different parts of the fly's range. For such exploitation, however, none of the parasites recorded from outside Nyasaland seemed, according to the writer's experience, likely to have the necessary qualifications—a short life-cycle, ensuring possibly a quick succession of generations, great fertility, and a disposition to accept captivity in the laboratory with equanimity. The Bombyliids as a family, for instance, have probably a very high reproductive capacity. This is certainly the case, for instance, with species which while on the wing scatter their ova along the galleries of termites; or with those that drop their ova round the entrance to burrows

tenanted by Gryllids ; or again, with some of the species known to be parasitic on the pupae of moths and of various Diptera which may be watched for the greater part of an afternoon depositing their ova here and there at frequent intervals in an apparently haphazard manner. But no Bombyliid with which the writer is acquainted takes kindly to captivity, those parasitic in Nyasaland on *G. morsitans* dashing themselves to pieces within a few hours ; hence the meagre details of their life-history that have yet been ascertained. The Mutillids also, judging by the life-histories of some of those found in Nyasaland, seem to be unsuitable for exploitation. They have a low reproductive capacity, their instinct being apparently surer than that of the Bombyliids and enabling them actually to oviposit either in or in the immediate proximity of their hosts, thus ensuring for their far less numerous offspring a much better chance of success than can be enjoyed by the larvae of the Bombyliids. Moreover, the life-cycle, at all events of *Mutilla glossinae*, is not only long, but of variable duration—often from twelve to seventeen weeks. Parasites other than these have been found so sparingly that very few details as to their life-histories are on record.

The introduction of suitable parasites into Nyasaland from without being out of the question, at all events for the time being, there remained, as it seemed to the writer, only the possibility of increasing the destructive value of the direct parasites of *Glossina* known to be already existent in the country. It is true that a natural balance between host and parasite must already have been struck, but the controlling agencies by which this has been affected are as yet in the case of many insects, in particular those parasitic on *Glossina*, merely a subject for vague speculation. Whatever the factors which limit the undue multiplication of these in nature, it seemed likely that a large and constant output of them from the laboratory into a fly area might well effect a measure of control, and was at all events worth trial.

For reasons already given, the Mutillids, Bombyliids and several rarer Chalcids were excluded from consideration for this purpose ; there remained only the possibility of using the Chalcid, *Syntomosphyrum glossinae*, Waterston, which is not only hyperparasitic on *G. morsitans* through Mutillids, but, as further investigations by the writer have recently shown, may be also directly competitive with the various other species. It may perhaps be well to quote some of the evidence in support of these conclusions. A puparium of *Glossina*, when chipped on 24th July, showed the cocoon of a Mutillid through which two days later some *Syntomosphyrum* were seen to thrust their ovipositors, and 3 males and 40 females emerged on 21st August ; from two other similar puparia attacked on the same day 7 males and 85 females emerged between 18th and 19th August ; from two more, 12 males and 59 females on 24th August. A particularly interesting puparium opened on 29th July was found to contain a Mutillid larva which had repaired the damage by 1st August ; it was then exposed to the attack of the parasites, 5 males and 42 females emerging on 24th August. Many other examples of attack on Mutillid-containing puparia were recorded. The following are some data relating to direct attack. A puparium from a larva deposited by a captive *morsitans* on 6th July was seen to be attacked by *Syntomosphyrum* on 7th, 8th and 12th July, 3 males and 40 females emerging on 9th August. Another puparium from a larva of 8th July was attacked by the parasites on 18th July, and probably before this, 23 males and 79 females emerging on 10th August ; another puparium from a larva of 8th July was attacked 16th July, 2 males and 17 females emerging on 10th August ; another puparium from a larva of 8th July, attacked on 9th July, afforded 9 males and 37 females on 11th August ; a puparium from a larva of 23rd July, attacked on 25th July, afforded 7 males and 19 females on 27th August. Many similar examples might be cited.

Syntomosphyrum had the other qualifications necessary for the experiment contemplated. Its life-cycle, though rather variable, occupies on an average about a month ; its offspring may be numerous, and it is extremely easy to deal with in captivity. The problem arose as to how it could be bred in very considerable numbers.

To utilise the puparia of *morsitans* itself was entirely out of the question, for it is difficult either to obtain them in any number from captive flies, or to collect a sufficiency from natural breeding places. A solution to the difficulty was found as a result of some work, undertaken in 1919–20, on the parasites, particularly Chalcids, of the various house- and blow-flies of Tanganyika Territory and Nyasaland. It was then shown that such Chalcids, if denied the opportunity of ovipositing within the puparia of their natural hosts, will attack those of a variety of other Diptera submitted to them. An experiment with *Syntomosphyrum* speedily established that this insect would act similarly. It oviposited within the puparia of *Musca nebulo*, Patton & Cragg, and other house-frequenting flies, in the puparia of a Trypetid, *Dacus brevistylus*, Bezzi, in those of *Chrysomyia putoria*, Wied., in those of a species of *Sarcophaga*, etc. The average number of parasites from each kind of puparium of the same age naturally varied according to its size. For example, the fresh puparia of *M. nebulo* afforded on an average 16 (2 males and 14 females), an estimate based on data obtained in 20 instances. The fresh puparia of *Dacus* afforded on an average 21 (4 males and 17 females), the estimate being based on the examination of 16 puparia; the fresh puparia of *Chrysomyia* afforded on an average 93 (26 males and 67 females), the estimate being based on an examination of 7 puparia; and the fresh puparia of *Sarcophaga*, attacked within a few hours of pupation, afforded on an average as many as 17 males and 50 females, the estimate being based on data obtained from 100 puparia. Fifty puparia of *Glossina*, on the other hand, afforded an average of 34 (4 males and 30 females) each.

There was very considerable variation in the number of parasites emerging from similar puparia, some of which also were larger than others. In one instance a puparium of *Sarcophaga* afforded 134 (40 males and 94 females). The proportion of males to females varied very considerably also, on one occasion a single male emerging to 44 females. Broods all of one sex were occasionally obtained; two puparia of *Sarcophaga*, for example, submitted to one female afforded 13 and 30 males respectively, and in other instances all-male broods of 37, 37 and 27 were recorded, also from *Sarcophaga*. On one occasion 28 males emerged from a puparium of *Glossina*, and no females. The parasites exercised some selection in their choice of puparia, attacking those of *Sarcophaga* far more readily than those of *Chrysomyia*, for instance, and the insects bred from these larger puparia were more numerous, larger and more lusty than any obtained from the smaller ones.

Pairing took place almost immediately on emergence, the males indeed waiting at the aperture of exit from the puparium and often entering into brisk competition for the possession of the emerging females. That there should be any rivalry at all is difficult of explanation in view of the disproportionately large number of females usually available. In one instance, 4 males out of 5 that had emerged at the same time with 22 females, paid no attention whatever to these, but remained on the puparium round the aperture, making occasional onslaughts on each other, as if in expectation of the emergence of mates more attractive to them. The question of parthenogenesis in these insects was not fully gone into, though reasonably to be expected in view of the large excess of females almost invariably obtained.

The females were ready within a few hours of emergence to attack a fresh supply of puparia. A phenomenon of some interest was the emergence of a second, and very rarely a third brood of the parasites from one puparium, invariably that of one of the larger species of Muscids. For example, a puparium of *Sarcophaga* attacked by one of the insects on 3rd May afforded 16 females and one male between 27th May and 4th June, 4 females and 39 males on 27th June, and 6 females and 2 males on 10th July. Attack by several females on different dates is suggested as the probable explanation. In the larger puparia, moreover, there is often more food material than is required for one batch of larvae (the offspring possibly of a female whose capacity had already been reduced by previous ovipositions), and as the reproductive

instinct of these insects is exceedingly strong, the females sometimes take advantage of the chance of ovipositing in the puparium from which they themselves have emerged. This must still contain material available for the sustenance of the larvae; hence the second brood. Their instinct is certainly faulty at times, for they were occasionally seen attempting to oviposit in puparia the contents of which were found on immediate subsequent examination to be dead long since and thoroughly dry.

The puparia of *Sarcophaga* could be obtained in almost unlimited numbers, and so it was clear that they were well suited for the attempt to obtain a very large supply of the parasite.

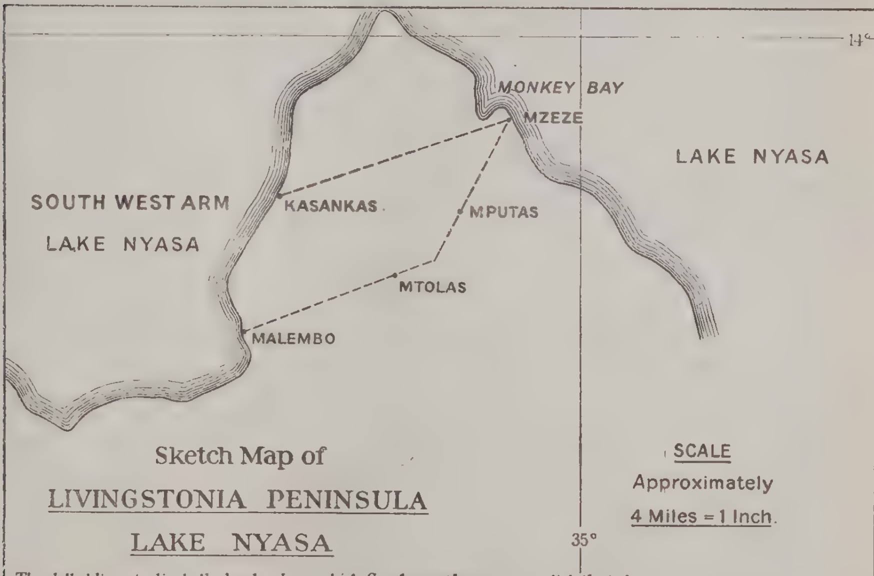
At the commencement of this work in April 1923, 11 female parasites bred from a puparium of *Glossina* were supplied with some puparia of *Sarcophaga* in specially designed breeding-boxes. By the end of the month several hundreds, the offspring of these eleven, had been bred, and at the end of May they had been increased to several thousands, for more female parents bred from *Glossina* had been obtained. During June about a thousand puparia of *Sarcophaga* were subjected to the attack of the parasites, such being the success attending the laboratory methods that not a single fly emerged from any of these, and twenty, chosen at random and broken open, all showed the Chalcids in various stages of development. It was particularly gratifying still later on, in September, to be able to demonstrate to the Principal Medical Officer on his visit to the laboratory that every single puparium selected by him at random out of many batches contained the parasites. It had been established in the meantime that the parasites, though bred for several generations through *Sarcophaga*, reverted without hesitation to attack on the puparia of *Glossina* when afforded an opportunity.

In late June a sufficiency of parasitised puparia to warrant a commencement with the projected field experiment was obtained, and it became necessary to select a suitable fly area, and to decide which of various methods available for the distribution of the parasites was most likely to be successful.

The area selected for the experiment was that in the Livingstonia Peninsula of Lake Nyasa, practically all fly country, with an area, very approximately, of about 42 square miles. This had the advantage that it was comparatively near one's base at Fort Johnston, and that though continuous towards the south with the vast fly area running from north to south along the west shore of the Lake and thence along the Shire River, it had on two sides quite natural limitations, the waters of Lake Nyasa, which would confine to a large extent any parasites that might be liberated. In this area also the percentage of puparia of *G. morsitans* parasitised had already been estimated, so that data for comparison with those to be obtained on the conclusion of the experiment were available.

It was considered that the best method of effecting the distribution of the parasites, and of securing their numerical increase, would be to deposit the parasitised puparia of *Sarcophaga* in the breeding-places of the tsetses, so ensuring their liberation in the most favourable situation possible. An initial difficulty as to how the puparia could best be protected from molestation by animals and from attack by other insects was overcome by disposing each in a section of bamboo, pointed at one end, so that it could be readily placed upright in the ground. The other end through which a puparium had been introduced was closed with a plug of mud of putty-like consistence, and at one side a hole was made, too small to allow larger insects to enter and just large enough to permit the escape of the parasites, which, it was anticipated, would find their way up to the beam of light coming through, and so to the outer world. This device was found to be entirely satisfactory in practice. The work of distribution, which was of necessity largely entrusted to natives, could not only be checked, but it was possible to place data labels with the puparia, to recover them at will, and to ascertain what percentage had produced parasites.

During the month of June (dry season) 350 puparia parasitised by *Syntomosphyrum*, and by the end of July 1,397, had been disposed in the selected area, along a line of devious native and game paths running from E.N.E. to W.S.W. for about 9 miles from the village of Mzeze to Kasankas (see sketch-map). Out of 78 of these recovered subsequently for examination, 76 had afforded parasites; it was estimated on this basis, and on the average of 67 parasites from each puparium, that approximately 23,137 males and 68,050 females had escaped. During August 895 more puparia bringing the total up to 2,292, were put out along the line Mzeze-Mputas-Malembo, about 5½ miles south at its maximum distance from the previous line, and running N.N.E. to S.S.W. for about 6¾ miles, and then from E.N.E. to W.S.W. a distance of about 7¾ miles. Of these puparia 43 recovered at random had all, except 6, given exit to parasites, so that, on the basis already stated, an approximate total of 153,564 (38,964 males and 114,600 females) had been liberated. The work steadily proceeded during September and October, by the end of which month it was estimated that a total of 277,179 parasites (70,329 males and 206,850 females, merely an approximate



The dotted lines indicate the tracks along which Syntomosphyrum was distributed.

estimate) had been liberated from puparia. Most of the puparia in these last two months were disposed along the line Mtolas-Malembo, it being there that the fly is usually most numerous.

There had been increasing difficulty in the intense heat of the late dry season (a mean maximum shade temperature of 97·5° F. in November), not only in obtaining the necessary blowfly puparia, but in breeding the parasites in them. It was thought at first that the season had become unfavourable for their propagation, or that the strain, having been bred for many generations through blowfly puparia, may have required the introduction of "fresh blood" obtained directly from the puparia of the tsetse. It had been hoped to maintain the output of the parasites well through the wet season, but as this was then proving difficult, the experiment was brought to an end in late November. The strain was, however, re-established early in January, so that more probably the temporary failure was due rather to some fault in the laboratory technique, possibly lack of sufficient care in regard to the sanitation of the breeding-boxes.

A study of the results was initiated at the beginning of 1924, by which time it was considered that even the parasites last liberated might have produced some appreciable effect. For this purpose as many puparia as possible were collected for retention pending the emergence of the occupants, whether tsetses or parasites, so obtaining data for comparison with those afforded by puparia obtained in 1922 and the first half of 1923 when the fly area was undisturbed. The total number collected in the fly area during 1922 was 935. Of these, 403 afforded *Glossina* (219 males and 184 females), 66 Mutillids, 51 Bombyliids, and 2 only broods of *Syntomosphyrum*. The 413 puparia remaining must have perished, for though kept well over a year none yielded any insects. The total number of puparia collected during the first five months of 1923 was 1,083. Of these 874 afforded *Glossina* (471 males and 403 females), 56 Mutillids, 24 Bombyliids, 6 broods of *Syntomosphyrum*, and 7 other species of Chalcids, the remaining 116 puparia perishing. The percentage of puparia parasitised by *Syntomosphyrum* works out at 0·4 for 1922 and 0·6 for 1923.

From June 1923 onwards until the end of the year no collection of puparia was made; for it was during those months that the distribution of parasites was carried out, and it was thought advisable that as many puparia as possible in the fly area should be available for their attack. In January 1924 the collections were resumed and continued until the end of March, a total of 516 new puparia being obtained. These afforded 359 *Glossina* (198 males and 161 females), 6 Mutillids and 35 broods of *Syntomosphyrum*. The remaining 116 puparia perished. The percentage of puparia parasitised had risen to 8·7.

It is perhaps of some value to give the data for the first three months of the years 1922 and 1923 for comparison in tabular form with those obtained during the same period of 1924.

TABLE I.

	Glossina Pup.	*Glossina* em. Males.	*Glossina* em. Females.	Mutillids Males.	Mutillids Females.	Bombyliids.	*Syntomosphyrum*.	Per cent. of *Syntomos*.
Jan. 22	—	—	—	—	—	—	—	—
,, 23	133	21	25	7	13	4	—	—
,, 24	195	97	82	3	2	—	11 broods	5·9
Feb. 22	124	17	7	—	—	3	—	—
,, 23	184	80	60	1	6	—	—	—
,, 24	160	65	38	—	—	1	13 broods	11·5
Mar. 22	514	139	115	11	42	36	2 broods	·05
,, 23	412	199	137	1	2	—	1 brood	·02
,, 24	161	36	41	—	3	—	11 broods	12

The data for 1922 and 1923, whether for the first quarter or the whole year, demonstrate the extreme rarity of *Syntomosphyrum* under the then-existent conditions; those for 1924, the positive results that attended the experiment to exploit the parasite. It is true that a rise in the parasitism rate to the degree indicated is a far step from having effected a degree of control of the fly of real practical value. It should, however, be pointed out that the parasites were liberated during the dry hotter months of the year, when insect life generally is at a minimum, and when presumably the struggle for mere existence is keenest, and that, owing to the little temporary difficulty with the laboratory work, and, later on in May, owing to the desirability of proceeding on leave, their output was not maintained. It is suggested that such experimental work, with an even greater output of *Syntomosphyrum* maintained during the round of seasons might possibly be worth while. With efficient assistance, if only that of intelligent and reliable natives, there appears to be practically no limit to the numbers of the parasites that could be bred in the laboratory, at all events during the middle months of the year.

It might be stated that, though for the reasons already indicated *Mutilla glossinae* was considered unsuitable for exploitation, some experimental work was carried out for the purpose of ascertaining whether this also would attack in captivity other hosts than *Glossina*. It was found that it would do so, breeding, though reluctantly, on the puparia of *Sarcophaga*. For instance, on 11th April 1922, ten of these puparia, from larvae obtained on the previous day and sprinkled with dust from crushed tsetse puparia, were submitted to a female Mutillid that had emerged a few days previously from a puparium of *Glossina*, pairing forthwith. Seven of these puparia subsequently afforded its offspring, the actual data being given in the following table :—

TABLE II.

No. of puparium.	Date of attack.	Date of emergence.	Species.
1.	Seen 14.iv.22	9.vii.22	Mutillid male
2.	,, 12.iv. and 13.iv.	16.vi.22	,, ,,
3.	,, 13.iv.	—	No result
4.	,, 12.iv. and 14.iv.	8.vii.22	Mutillid male
5.	Not seen	12.vi.22	,, ,,
6.	Seen 13.iv. and 14.iv.	opened 23.i.23	Mutillid cocoon
7.	,, 12.iv. and 13.iv.	7.vii.22	Mutillid male
8.	,, 12.iv.	28.vi.22	,, ,,
9.	,, 14.iv.	6.vii.22	,, ,,
10.	,, 12.iv. and 14.iv.	opened 24.v.	No result

No results comparable with these were obtained in subsequent experiments. It will be noted that seven males were so bred ; these were considerably larger than any that emerged from *Glossina* puparia, as indeed were the few females obtained later.

The writer has again to record his grateful thanks to Mrs. A. G. Eldred for her kind and very able assistance in maintaining the work of the laboratory during his repeated absences.

COLLECTIONS RECEIVED.

The following collections were received by the Imperial Bureau of Entomology, between 1st July and 30th September, 1924, and the thanks of the Managing Committee are tendered to the contributors for their kind assistance :—

Mr. T. J. ANDERSON, Government Entomologist :—34 Coccinellidae and 2 species of Coccidae ; from Kenya Colony.

Dr. G. ARNOLD, Rhodesian Museum :—60 Coleoptera ; from Rhodesia.

Mr. E. BALLARD :—3 Lepidoptera ; from Queensland.

Mr. A. H. BEYER :—1 species of Aphididae ; from Florida, U.S.A.

Dr. G. BONDAR :—61 Coleoptera, 42 Lepidoptera and 10 larvae, 27 Rhynchota, and 3 Orthoptera ; from Brazil.

Mr. J. R. BOVELL, Superintendent of Agriculture :—3 Diptera, 3 Formicidae, 5 Lepidoptera, 20 Spiders, and 6 Slugs ; from Barbados.

Mr. H. E. BOX :—A number of Embiidae ; from British Guiana.

Prof. C. K. BRAIN :—215 Hymenoptera and 84 Rhynchota ; from South Africa.

Dr. H. BRAUNS :—11 Coleoptera ; from Cape Colony.

Mr. J. H. BURKILL :—7 Coleoptera ; from Singapore.

Dr. P. A. BUXTON :—3 Hippoboscidae, 235 other Diptera and 18 larvae, 18 Hymenoptera, 256 Coleoptera and 5 early stages, 40 Lepidoptera, 4 species of Coccidae, 3 species of Aphididae, 176 other Rhynchota, 54 Orthoptera, 3 Planipennia, 4 Termite nests, 3 Collembola, 3 Thysanura, 3 Millipedes, 150 Spiders, 18 Woodlice, 2 Snails, 2 Crabs, and 50 Shrimps ; from Samoa.

Prof. GIACOMO CECCONI :—3 Formicidae, 3 species of Aphididae, and 2 *Chrysopa* ; from Italy.

Mr. H. S. CHANG :—9 Orthoptera ; from China.

Mr. L. D. CLEARE, Junr., Government Economic Biologist :—3 Tabanidae, 4 other Diptera, 20 Parasitic Hymenoptera, 11 Coleoptera, 3 Lepidoptera, 4 Rhynchota, and 4 *Chrysopa* ; from British Guiana.

Mr. G. H. CORBETT & Mr. B. A. R. GATER :—150 Diptera, 456 Parasitic Hymenoptera, 19 other Hymenoptera, 108 Coleoptera, 111 Lepidoptera, 6 species of Aphididae, 41 other Rhynchota, 50 Psocidae, 5 Orthoptera, and 10 Mites ; from the Malay Peninsula.

Mr. H. H. CURSON :—7 Diptera, 9 Oestrid larvae, 6 Hymenoptera, 9 Coleoptera, 11 Lepidoptera, 4 Rhynchota, 6 Psocidae, 11 Orthoptera, and 13 Ticks ; from South Africa.

Dr. A. M. DAMPF :—12 Orthoptera ; from Mexico.

DIRECTOR OF AGRICULTURE, BAGHDAD :—7 Hymenoptera ; from Iraq.

DIRECTOR OF AGRICULTURE, GAMBIA :—7 species of Coccidae, 4 Orthoptera, and 58 Trombidiidae ; from the Gambia.

DIVISION OF ENTOMOLOGY, PRETORIA :—4 Curculionidae ; from South Africa.

Mr. P. R. DUPONT :—18 species of Coccidae ; from Seychelles.

ENTOMOLOGICAL SECTION, WELLCOME TROPICAL RESEARCH LABORATORIES, KHARTOUM :—13 Chalcididae and 372 Orthoptera ; from the Sudan.

Mr. T. BAINBRIGGE FLETCHER, Imperial Entomologist :—80 Orthoptera ; from India.

GOVERNMENT ENTOMOLOGIST, COIMBATORE :—16 Parasitic Hymenoptera, 12 Coleoptera, and 2 Lepidoptera ; from South India.

Mr. C. C. GOWDEY, Government Entomologist :—4 Coleoptera and 3 Lepidoptera ; from Jamaica.

Mr. E. HARGREAVES, Government Entomologist :—32 Siphonaptera, 6 Culicidae, 5 *Stomoxys*, 10 *Glossina*, 43 other Diptera, 13 Chalcididae, 300 Formicidae, 14 other Hymenoptera, 118 Coleoptera, 6 Lepidoptera, 97 species of Coccidae, 2 species of Aleurodidae, 96 other Rhynchota, 2 Psocidae, 10 Orthoptera, 7 Isoptera, 2 Hemerobiidae, and a tube of Mites ; from Sierra Leone.

Dr. W. HORN :—750 Orthoptera ; from various localities.

Mr. J. C. HUTSON :—17 Lepidoptera and 333 Isoptera ; from Ceylon.
Dr. A. INGRAM :—7 Culicidae ; from the Gold Coast.
Mr. F. P. JEPSON :—10 Scolytidae ; from Ceylon.
Mr. H. H. KARNY :—2 Microlepidoptera ; from Java.
Mr. C. R. KELLOGG :—229 Coleoptera and 85 Orthoptera ; from China.
Dr. I. J. KLIGLER :—40 Tabanidae, 23 other Diptera, 10 Hymenoptera, 131 Coleoptera, 3 Rhynchota, and 2 Orthoptera ; from Palestine.
Mr. C. BODEN KLOSS :—644 Coleoptera and 64 Orthoptera ; from Singapore.
Dr. W. A. LAMBORN, Medical Entomologist :—30 Diptera and 3 early stages, 227 Chalcididae, 16 Curculionidae, 2 Lepidoptera, and 7 Planipennia ; from Nyasaland.
Mr. C. H. LANCASTER :—1 Lepidopterous pupa case ; from Costa Rica.
Dr. LL. LLOYD:—2 Nycteribiidae, 41 Hymenoptera, 233 Coleoptera, 76 Rhynchota, 496 Orthoptera, 15 Planipennia, 59 Odonata, and 2 Bats ; from Northern Nigeria.
Prof. R. MATHESON, Cornell University :—9 Diptera, 11 Curculionidae, 4 Lepidoptera, and 47 Rhynchota ; from Ithaca, U.S.A.
Dr. E. MJÖBERG :—177 Coleoptera and 19 early stages ; from Borneo.
MUSEE DU CONGO BELGE, TERVUEREN :—143 Orthoptera ; from Africa.
Mr. J. C. MYERS :—16 Spiders ; from New Zealand.
NATIONAL MUSEUM, MELBOURNE :—14 Diptera ; from Australia.
Mr. L. OGILVIE, Plant Pathologist :—4 Diptera, 7 Coleoptera, 56 Lepidoptera, 3 species of Coccidae, 40 other Rhynchota, 2 Isoptera, 8 Woodlice, 5 Spiders, and 2 Millipedes ; from Bermuda.
Prof. A. N. PAVLOVSKY :—2 Nycteribiidae and 200 other Diptera and early stages ; from Russia.
Mr. F. R. PETHERBRIDGE :—2 Lepidoptera and 1 pupa ; from North Spain.
Mr. A. W. J. POMEROY, Government Entomologist :—6 Culicidae, 21 other Diptera, 13 Hymenoptera, 61 Coleoptera, 86 Lepidoptera, 20 Rhynchota, and 3 Mantispidae ; from Southern Nigeria.
Mr. H. W. SIMMONDS, Government Entomologist :—3 Culicidae, 10 other Diptera, 12 Chalcididae, 15 Coleoptera, 5 Lepidoptera, 2 species of Coccidae, 5 other Rhynchota, and 50 Mites ; from Fiji Islands.
Miss F. M. SINKEY :—4 Diptera, 11 Hymenoptera, 48 Coleoptera and 4 larvae, 2 Lepidoptera, 6 Rhynchota, 6 Orthoptera, 2 Odonata, 2 Plecoptera, 2 Ephemeridae, and 5 Spiders ; from China.
Mr. H. P. THOMASSET :—38 Culicidae, 2 *Auchmeromyia*, 508 other Diptera, 137 Hymenoptera, 13 Coleoptera, 46 Lepidoptera, 114 Rhynchota, 5 Orthoptera, 3 Trichoptera, and 2 *Chrysopa* ; from Natal.
UNIVERSITY MUSEUM, CAMBRIDGE :—2 Tabanidae, 25 other Diptera, 25 Hymenoptera, 335 Coleoptera, 30 Lepidoptera, 61 Rhynchota, and 3 Orthoptera ; from Nigeria.
Mr. F. W. URICH :—8 Parasitic Hymenoptera and 7 Rhynchota ; from Trinidad.
Mr. R. VEITCH :—3 Culicidae, 7 Tabanidae, 334 other Diptera, 32 Hymenoptera, 80 Coleoptera, 17 Lepidoptera, 31 Rhynchota, 12 Orthoptera, and 3 Ephemeridae ; from Fiji Islands.
Mr. D. S. WILKINSON, Government Entomologist :—10 *Chrysops*, 18 Chalcididae, 55 Coleoptera, 31 Lepidoptera, and 2 species of Aphididae ; from Cyprus.

AN EXPERIMENT IN CONTROL OF TSETSE-FLIES AT SHINYANGA, TANGANYIKA TERRITORY.

By C. F. M. Swynnerton, F.L.S., C.M.Z.S.

(Plates IX–XV and Map.)

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I.—Introductory.

At the beginning of 1923, in Section xxii of my paper on "The Entomological Aspects of an Outbreak of Sleeping Sickness near Mwanza, Tanganyika Territory (Bull. Ent. Res. xiii, pp. 357–365), I stated clearly my views as to the correct methods of attacking the tsetse. For late grass-burning, one of my measures, I had already stated the case in detail in a previous paper, in which also I laid stress on the value of "settlement, properly planned," for the destruction of fly-belts (Bull. Ent. Res. xi, 1921, pp. 315–385).

On my return to Tanganyika Territory from leave in 1923, I selected the Shinyanga sub-district of Tabora as the first large experimental area and proceeded to put my views on control to a practical test. The results so far have been most satisfactory and encouraging.

For this instalment of success and for aid generally in the work that has been carried out in Shinyanga, I am deeply indebted to Mr. H. C. Stiebel, O.B.E., Senior Commissioner, Tabora, who has the solution of our tsetse problem no less at heart than myself, and whose exceptional enterprise and energy are the greatest asset of the campaign; to Mr. A. A. M. Isherwood, who was Acting Senior Commissioner

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during my first stay in the area, and who gave me every support ; to Mr. C. McMahon, M.C., Administrative Officer in charge of Shinyanga during that visit, for his enthusiastic and untiring personal help both then and after I left, and for assisting me to lay the foundations for the practical application of the scheme generally ; to Major W. E. H. Scupham, M.C., Administrative Officer in charge during my second stay, who was associated with me in the organisation of the great clearing operations that were carried out and in the control of grass-burning, and who has supported me splendidly in all my needs ; to the Acting Chief Veterinary Officer, Capt. F. J. Sheedy, M.B.E. ; to Mr. W. Burns, the District Veterinary Officer, for present assistance ; to Capt. Hornby, the Veterinary Pathologist, who during a visit to Lubaga in February helped greatly in relation to the work there undertaken and carried out a first trypanosome survey, also demarcating for future comparison the present boundaries of the areas in which it is possible to keep cattle and goats respectively, and whose excellent and interesting report should be read in conjunction with this one ; to Mr. H. Wolfe, Acting Director of Agriculture, for most useful co-operation towards the close of 1924 ; to Mr. C. Gillman, for much information as to the distribution of fly ten years ago ; to Mr. S. P. Teare, my Game Ranger in charge at Kizumbi, whose assistance has been invaluable ; and, not least, to the enthusiasm of the Wasukuma people themselves and the interest and helpfulness of their Sultans. Of the latter, Wamba, particularly, has placed himself almost continuously at my disposal and has been of the greatest service. The services of my head fly-boy, Swedi bin Abdallah, have been of so outstanding a character that mention of them should not be omitted.

A particularly gratifying feature has been the really hearty co-operation of the Departments—Administrative, Veterinary, Agriculture and Game—and the prospect that with the appointment of a doctor to Shinyanga the Medical Department will also be able to step in and assist us in its own most important rôle—the furtherance of the increase of population ; for without a good and continuous increase of population there can be no indefinite extension of the control of the fly, at any rate by means of clearing measures and settlement.

Finally, referring no longer to the Shinyanga work in particular, I take this opportunity to express my gratitude to Sir Horace Byatt, K.C.M.G., the late Governor of the Territory, to Mr. John Scott, C.M.G., Chief Secretary and now Acting Governor, Mr. A. C. Hollis, C.M.G., who held these positions previously, Mr. A. E. Stack, O.B.E., and the Treasurer, Mr. R. W. Taylor, O.B.E., for their constant support of my work and the very free hand they have always allowed me, without which even such success as has been attained would have been impossible. Amongst the Administrative Officers who in other districts than Shinyanga have contributed to the control of tsetse by their energetic and successful work in favour of more concentrated settlement on the part of the bush natives and have proved the feasibility of this measure, special mention should be made of Mr. A. M. D. Turnbull, Senior Commissioner of Mwanza (who has also done much otherwise in relation to the tsetse in his district), Mr. A. L. Henniker-Gotley, of Tunduru and Kilwa, and Mr. W. J. Stevenson, of Kahama.

II.—The Country and the Fly.

Shinyanga is gently undulating country, ideal in this respect for the use of ploughs. Hills and smaller outcrops of granite and ironstone occur in places. The soils, for the most part, are rich—a red, gritty soil, producing fine food-crops and ground-nuts, and quite good cotton, and a black soil, well-drained, usually with lime nodules underlying, that gives yet finer yields of cotton. The great attention that is commencing to be given to the sub-district in the matter of agricultural development and the fact that it is proposed to build a railway to it increase its suitability as the subject of our first attempt to control tsetse-fly.

Owing to tsetse, about half of the district is depopulated, and this half contains (according to native views) the best soils and the best pasture. There are two large areas of great and compact population, a smaller one in the south-west and a larger one in the east. These are shown white on the map. The total population is 150,000; agriculture and cattle-keeping are nicely combined, and tribal authority survives.

The vegetation is divisible into two main categories: bush and open country, both of them well dotted with baobabs.

The bush coincides with the country which has been depopulated, for bush grows up when people go out, and the open country is mere "culture steppe"—*i.e.*, country that is open purely through and during the presence of sufficient population, the bush being kept down by cutting for firewood and building and by the browsing of live-stock. The roots of many of the trees and bushes still remain, suppressed but alive, below the ground and form new bush when the suppressing factor goes or thins. The baobabs form the great feature of the settled country, simply because they are too troublesome to cut down and, thus isolated, they are of no importance in relation to fly. The bush is broadly divisible as follows:—

(1) "Ilula" bush, of small gall-studded, ant-infested acacias (*A. drepanolobium* and another) that occurs in or more especially on the margins of the "mbugas" or seasonal swamps. These swamps form a connected network east of the Mhumbo River, as may be seen on the map, and, lying at about lake-level, formed the foundation of a scheme formulated by the Germans for a canal that should pass south from Smith's Sound, join the Manonga head-waters, and follow that stream to its junction with the Wembere, for the irrigation of the splendid flats adjoining these two rivers (Pl. xi, fig. 2). "Ilula" bush, valuable for its gum, out of which the natives make much money, and often on its margins a concentrating ground in the dry season for *Glossina morsitans*, is not a favourite with *G. swynnertoni*. That fly dribbles into and through it in small numbers where it is adjacent to the type of bush next to be described, but is absent, or practically so, from detached areas of ilula, and in the heavier rains deserts even undetached blocks of it on the margins of the fly-belt to such an extent as to enable cattle to be grazed there. The black soil most commonly associated with ilula is sour, so-called cotton soil—*lucus a non lucendo*.

(2) The thorn bush of the better drained soils (Pl. x, fig. 1). This is low savannah wooding composed in part of acacias of some size (*A. spirocarpa*, *A. arabica*, and others—very much like the Zululand fly-bush), in part of *Commiphora* and its associates, this usually forming typical "orchard bush" (Pl. x, fig. 1). Thickets are freely interspersed through the older wooding, and in these, chiefly, the fly breeds and concentrates. These dense thickets follow also the water-courses, dry for most of the year, and are here often interspersed with taller trees, including the "Mgu" (*Acacia campylocantha*, Hochst.), shown in Pl. xiv, fig. 2, of my Mwanza paper.

This type of thorn bush, *Acacia* and *Commiphora*, is, in Shinyanga, the fly-bush proper, and it contains practically no population. In respect of tsetse it is inhabited for the most part by *G. swynnertoni* only, but *G. morsitans* has penetrated it from Kahama into the western borders of Nindo. West of this line again the two flies overlap for a few miles, and several specimens of *G. pallidipes* also were taken by my fly-boys and myself in south Nindo, in country of closely-scattered thickets interspersed with large trees of the genera *Pterocarpus*, *Strychnos* and *Combretum* (Pl. x, fig. 2). A single specimen of *G. pallidipes* was taken between Shinyanga and Kizumbi. This was the first fly other than *G. swynnertoni* to be taken east of the Nindo area in a whole year of catching, and its capture suggests a very sparse distribution of this apparently somewhat highly wandering fly that is reminiscent of the position in Zululand.

Whether *G. morsitans* is really invading the *swynnertoni* area (see Map), or whether the overlap merely represents a seasonal spread from the *Brachystegia-Berlinia*

wooding of Kahama, I do not yet know, but *G. swynnertoni* has, in the last three years, begun very definitely to invade the Nzega sub-district, passing by way of Mount Kisuge into the great *Acacia-Commiphora* areas south of the Manonga River.

In Shinyanga impala is the dominant antelope (except perhaps in Nindo), but eland, steinbuck, dikdik and wart-hog are fairly abundant also in the bush. Giraffe are often met with, and in respect both of game and of the high proportion of male tsetses taken this area differs completely from the main sleeping sickness area of Mwanza, enclosed between Usmao and the Duma, as this was when Mr. Turnbull and myself investigated it before it was evacuated by its human population. Roan antelope and zebra are present in small herds locally in the general bush, and ostrich, wildebeest, Thomson's gazelle and zebra are found in numbers on the greater mbugas (Pl. xi, fig. 2). There are topi in Nindo, and a few hartebeest and rhinoceros are present also. A few dikdiks persist in the culture steppe, and Thomson's gazelle occurs on its borders, while roan antelope and, especially, eland, zebra and ostrich occasionally visit the crops on the margins of the settlements ; but in general, open, occupied culture steppe has little or no game, and it merely requires the clearing and effective occupation of a piece of country to banish the game from it.

Shinyanga, like the neighbouring district of Mwanza, is the scene of energetic propaganda for the large-scale growing of cotton, and the natives are taking it up keenly.

III.—History.

History or tradition, as related to me by Sultan Wamba concerning the Sultanates from Tinde eastwards, states that the first Msukuma to come to Shinyanga was Mwola, a mighty hunter from Mwanza. He came to hunt in what was then a great bush country, teeming with elephant, buffalo and every other kind of game, with his wife Giti and three of her attendants, and, settling there, gathered round him the adventurous spirits of the surrounding tribes. Giti, daughter of the Chief of Nyegezi (Mwanza), being of blood royal, was made first chief and, despite Saturn-like fears and proclivities on the part of the husband, her nurse, Ushola, succeeded in saving the third man child by disguising him as a girl. Mwola was duly ousted by the latter. Giti has been succeeded by nineteen chiefs, including the present Sultan, Wamba. The names and places of burial of all have been preserved.

The people having become numerous, the eighth chief divided the land into nearly its present divisions, each under a sub-chief, and the same was done by the Chief of Msalala for the western or Wanyamwezi Sultanates—Nindo, Lohumbo, Mangoi, Kiguhumo and Makarundi. The first settlers in these had gone there as purveyors of dried meat and lion fat to Msalala. The sub-chiefs later became independent.

An agreement was made in the east that any section making war on another should be set upon by all the others, also that any chief planning war should be deposed and punished by his own people. It is stated that this agreement was kept, on the whole, and that, till about forty years ago, agriculture and cattle-breeding developed more or less steadily. The bush was pushed back and back until only a portion of Nindo, the mbugas of Seke and an area in Seke, Mwadui, Uchunga and Usiha, contained appreciable bush. In the bushy half of Nindo no cattle were kept, but only goats in small lots of six or eight. Nindo was kept thus bushy and tsetse-infested by two successive depopulations : the first by Kishiba of Msalala, who carried his wars successfully into Arab Tabora itself ; the second by all the surrounding Sultanates, as the result of Nindo having become the nest of a gang of cattle-thieves under a daring headman, Kasenga. The demands made by the earlier German safaris to and from Mwanza on the Nindo path were so excessive in relation to its small

population that many of the people remaining migrated to more heavily populated parts, and man-eating lions more than once hastened the process, and so assisted the tsetse to dominate.

The remaining outstanding events remembered are a war made on Usule by Whimo, a manangwa of Msalala, and a great mortality through dysentery or an allied disease and a subsequent outbreak of small-pox, both relatively recent.

Following on the small-pox and the punishment of Nindo came three raids by the Urambo chieftain, Milambo, an interval of one year and of three, respectively, intervening. Aided by his Zulu (Wangoni) auxiliaries from that tribe's northernmost outpost, near Runzewe in north Kahama, he fired the villages, seized the cattle, took the younger people as slaves, and killed the older and (after passing on the second time into Mwanza) returned with much booty. Famine followed, but was not serious, for food was obtainable from Nera, to the north, but it added to the unsettlement of the people. Large numbers, concluding that proximity to Urambo was dangerous, moved north and north-east into Mwanza and east into the far side of the present Shinyanga sub-district.

The "league" then broke up in intrigue and internal fighting, for, as Sultan Wamba put it, "Milambo had shown the chiefs how easy it would be, amongst peoples pledged to peace, for a man who secretly organised for war to subdue his neighbours and add to his possessions." Kapela, Sultan of Bukuni, in Kahama, associate in Milambo's raids till he provoked him purposely and defeated him, and inheritor of the services of his Zulus, remained specially prominent. After one or two initial reverses he allied himself first with one chief, then with others, to attack each time a third party and carry off its remaining cattle. Shinyanga Sultanate was a sufferer. Kapela's last war, in which, in alliance with the chiefs of Tinde, Usanda, Shinyanga and Usiha, he attacked Samuye and, slaughtering its inhabitants, reduced them to four villages only, occurred at the very time that the Germans were fighting the Sultan of Tabora. Next came the German occupation, and a few unimportant raids by Masai, and after these the great first rinderpest, which was as disastrous to cattle here as elsewhere and exterminated the buffalo and kudu.

By this time, as a result of depopulation, a great area of bush had sprung up where all had been open grazing land and cultivation. But so far nothing was generally heard of tsetse, and the people, settling down to reconquer their country under European protection, could graze their increasing cattle in the bush as well as out of it; and the bush is said to have taken on the chequered appearance, broken by fields and patches of open grazing, that to-day characterises much of Nzega. It was at the time of the first institution of a station at Shinyanga that the threat was beginning to become acute with the advance of the tsetse "modya modya" (one at a time) through this bush from Nindo. Old men of Nindo tell me that that Sultanate was well infested before the great rinderpest except towards Shinyanga, but that the fly then disappeared. Subsequently they found it again in the Sorwa section of the bush, about Bulabu (see Map), and this, they believe, was the fly that then advanced. But, they say, they were surprised, for whereas the original fly killed only cattle and did not spread, this one killed both cattle and goats and spread rapidly.

Sultan Mwanasali of Nzega tells me that he himself saw tsetse before the rinderpest in Seke, in bush which then connected with the bush areas of west Mwanza, the chief home to-day of *G. swynnertoni*; also west of Seke, in north Nindo; and one old man who in 1923 gave me the same information as to Seke insisted that the first spread of fly subsequently to the rinderpest was from there. My own theory, on the information available, and the distribution of types of woodland, would be that the fly that inhabited Nindo before the rinderpest and spared goats was either *G. morsitans*, *G. pallidipes*, or both, these being found there even now; but that the fly that had reached Seke and perhaps north Nindo was *G. swynnertoni*, that this

either lingered somewhere after the rinderpest or re-entered from Mwanza before the bush connection was finally cut, and, gaining numbers, advanced and carved out its new fly-belt.

The German officer then in charge of Shinyanga, by name Höntsch, wished, it is said, to clear away a band of wooding, a thousand or more yards wide, across the fly's advance. This was not done, and the fly came on steadily until, driving the cattle everywhere out of the bush, it came face to face with the advance of the denser settlement on its margins.

The first breach in this line of settlement was made fourteen years ago. This was near Shinyanga itself, where, in 1909, four man-eating lions became so troublesome, killing in all about thirty persons, that a great number of people deserted. Bushes grew up on their gardens and grazing land, and the tsetses, arriving later and pushing into these, made the ground to right and left of the gaps untenable by the cattleowners living there, and these also fell back. The first very general retreat in face of the tsetse occurred ten years ago, and since then the process has been continuous. The tsetses unaided have proved amply sufficient to keep the people in steady retreat, but in point of fact they have been assisted, and retreats locally precipitated, by all of the many reasons which cause a native to evacuate his garden or his grazing. In one place it was the drying up of water-holes; in another the mere need for shifting that is necessitated by the native's impermanent methods of cultivation; in yet another the repeated early burning-out of grazing by irresponsible honey-hunters in the neighbouring bush; and in another (Usule and Usanda) proximity to a depot, and therefore forced labour, during the war; and the methods of Wamba's predecessor helped to expel population. In every case the small local evacuation has been seized on promptly by the tsetse and wider retreat brought about.

IV.—The Seriousness of the Position in Shinyanga.

It has been shown how like the position is to the holding of a front in war. A small section of the line is evacuated for some reason, and the enemy at once pours in and makes the line untenable. Another withdrawal takes place, and in the deserted area the long-suppressed bush springs up with rapidity from the never-dying roots, and when this is only three or four feet high tsetses are carried in and left in it by the passage of people. The cattle which are still grazing there become infected, or the mere news of the presence of tsetse suffices, and evacuation again commences. During the last ten years the general retreat would appear to have been at the rate of a mile a year. Due west of Shinyanga Boma the rate is stated to have been two miles a year since 1912.

In addition new fronts have been established by the tsetse as the result of some of the evacuations. A broad bridge of bush has grown up between the infested bush-area in the north and a large uninfested bush-area in Samuye, and the fly, pouring into the latter in the last seven years and passing round Kisuge, where it has met *G. morsitans*, is now advancing on the great Uduhe-Usiha cattle-area on fresh fronts. Each of the two main cattle areas of the sub-district is now nearly surrounded.

The account of the position given me by the Senior Commissioner (Mr. H. C. Stiebel) and quoted in my published Mwanza report (Bull. Ent. Res. xiii, p. 360) was an excellent description of the exact position. There is no sign of a barrier at which the invasion would have stopped. The natives, till we turned them, were definitely "on the run." Everywhere on the edges of the cattle-areas there was the same advance of the young bush and the tsetse, and everywhere inside them are still the live roots of the suppressed bush. The natives themselves were highly alarmed, and some said to me, "Where will the end be?" I replied, "Unless

you stand firm and yourselves attack, the end will be in little more than twenty years with the death of your last beast somewhere in Uchunga." The cattle threatened number about 345,000.

I may add that it would have been useless to think about ox-transport or ploughing for the natives of this sub-district except as a transient affair, unless the advance of the tsetse were finally stopped. Close up to the spot where the men and oxen were being trained by the Government to ploughing and wagon-work (Usogole, in Usiha—last year thought to be safe) and on the grazing, there are up-growing areas of acacia which must be cleared this year. Tsetses are now found at the drinking-places of these Usogole cattle, and they are being regularly carried by the natives of the villages thereabouts into and through the grazing.

The retreat in front of the fly, added to natural increase, has brought about a congestion of cattle in the two surviving cattle-areas (shown white on the Map) and a consequent great shortage of grazing. Even in June such areas as Usiha were grazed "to the bone" and grassless stretches of red earth might be seen (Pl. ix, fig. 1). In those parts that had been stripped of grass in past years much wash has already taken place, producing channels (Pl. ix, fig. 2) and, in parts, the disappearance of the soil down to the rock or to broken stone, on which nothing but thorn-scrub (and tsetse) will be able to exist.

In contrast to the condition here seen may be cited the magnificent untouched grazing everywhere in the tsetse-bush.

As a result of these facts the natives, late each dry season, take great risks in pushing their cattle into the "fly," and incur losses of which it can only be said that at any rate they are less than would be incurred through starvation of the cattle.

Further, the one appreciable piece of reserve grazing that was fly-free, namely, the Mwambiti bush-area on and across the Manonga, is now in process of being invaded by both *G. morsitans* and *G. swynnertoni*.

It was already obvious during my first visit that matters could no longer be allowed to drift, but that the situation must be taken strongly in hand.

V.—The Control Measures recommended.

For the spread of the fly the natives have the remedy in their own hands; for a cutting back each year of the new growth on the margins of the cattle areas would suffice to keep the fly where it is to-day.

For the scarcity of grazing and the deaths of their cattle the remedy is in their hands and ours. If they choose each year to include in their marginal clearing a cutting back into the older bush they will extend their grazing. And if we take care to place the new economic cultivation, planned on a large scale for Shinyanga, so far as possible in the fly-bush, with its very excellent soil, we shall to that extent avoid robbing the people of their already-existent grazing, while consolidating some small portion of the clearing through the stumping that the ploughing will necessitate.

The case of Ngasa's wood near Kizumbi, which is somewhat detached from the main belt and in which 700–800 head of cattle are running, and the instances, three in number, in which semi-detached or out-jutting portions of the Shinyanga-Mwanza fly-belt cleared themselves of fly three years ago as the result probably of unusual seasonal conditions (combined perhaps with consequent heavy burning), encourage the belief that, however futile it may be to start measures against the side of a huge intact fly-belt, as any one who passes in the train from Kazikazi to Kigoma will realise), the breaking off from that belt of blocks of a limited size by means of sufficiently effective barriers will enable us to attack those blocks individually with the success that attended the measures that were taken in the limited area of the island of Principe. The destruction of the breeding thickets in the case of

G. swynnertoni, and of the dry-season foci in the case of *G. morsitans*, in each case in combination with late, fierce grass-burning, may suffice in the case of such blocks, but the latter will in any case afford us the opportunity for the application of control measures of any kind on a manageable scale, such as breeding and releasing parasites, localised exclusions of all or particular food-animals, or the provision of logs or other trap breeding-places to be turned over frequently for the exposure of the pupae to the sun (*vide* observations on the mortality in pupae in exposed ground, Bull. Ent. Res. xiv, 1923, p. 119).

The cutting off of several such blocks would enable us to test a different measure in each of them, and it is hoped to use the Shinyanga fly-belt in this way.

It may be that organised late grass-burning, extending over several years, may in itself suffice and may replace the other measures that I have referred to.

In the meantime, not merely the new cotton cultivation, but all factors that may lead to the clearing of bush and the attraction of settlement, should, in conformity with our general scheme for the reclamation of the fly-area, be located where they can best exercise this effect.

Thus, it having been suggested that the Administrative Station should be moved, it would be a mistake to place it in country already congested. It might well be opened at Kizumbi, and settlement will then be attracted thither, which would be an aid to us in our fight. As the Senior Commissioner has said : " It would be wrong to preach to the natives that they must stop running away, and then to run away ourselves."

Everything in a fly district, so far as is reasonably possible, should be made to subserve the end of reclaiming from the fly the valuable grazing and soil that has been seized by it and of averting any enhancement of the congestion that exists in the cattle areas.

VI.—An Experiment in Barrier-formation and Control.

It was desirable to select a typically-infested block of bush which could be cut off from the main bush and used as a field for experimental measures of control. It was also felt that it would be inadvisable to take, for a first trial, an area that might prove too large to attack with the resources available. Accordingly, after examination of the margins of the fly-belt, Lubaga was selected ; for there was here a small projecting block of bush which contained, in addition to breeding thickets, all of the three main types of wooding that compose the fly-belt and was typically and heavily infested. It is between Kizumbi and Shinyanga on the Mwanza-Tabora road.

The points to be tested were : (*a*) whether, and what, inducements will bring people to live in the places in which we wish to produce open culture steppe ; (*b*) the people having come, how wide a barrier of culture steppe will be necessary to prevent the continual re-stocking with fly of the area cut off, and the means of preventing the fly from crossing the barrier ; (*c*) the means of clearing the block of the fly already contained in it.

To facilitate an early start with the barrier a clearing was made right through, a thousand yards wide at its widest point and three or four hundred at its narrowest, late in 1923.

The inducements decided on were a three years' remission of Government obligations and a share in a piece of land which we would plough (a suggestion of Mr. McMahon's) for any settlers that might come. The matter was explained at a meeting of the natives, and it was asked whether anyone cared to settle in the strip. A man at once got up, said he had been driven thence by the fly several years before, and wished to go back. But it was late in the year and he had no time to build and

hoe. We at once offered him assistance with his hut and his garden, whereupon three more, all wishful to return to their old homes, volunteered, and two more did so during the next few days.

That was as much as could be expected at that time of year, but a number more came in in 1924, and it appears to require merely a little advertisement, which, owing to the stress of the larger operations of that year, was not offered, to obtain many more. Ploughs were bought, cattle-kraals were built, ploughboys and drivers were trained, and ground was ploughed in a rich area in the margin of the fly-bush, which was specially cleared for the purpose (Pl. xiv, fig. 2). Food crops, groundnuts, and an excellent cotton-crop were raised by our "settlers" on this ground, and their pleasure at the sums obtained for the cotton promises to be the best advertisement of all. A much larger acreage has been stumped and ploughed this year.

Goats have been distributed on loan to each settler, both as an additional inducement (they return only the original number to the Government), and to help keep down the young shoots from the bush cleared, and a reserve of goats for the latter purpose is being built up, the total at present numbering about 1,800.

Every effort should be made to increase the numbers of these animals in contact, anywhere, with bush that might be infested, and to discourage the wholesale trading and slaughter that now keep them down. They will not live everywhere in close contact with the tsetse itself, but this is not necessary; and it is, on the other hand, interesting that, at Lubaga, goats given out in small lots to the "settlers," and bitten all the time, are doing excellently, while the reserve lot, based on the homestead and less exposed to fly, but (as we found) badly looked after and allowed to run down in condition, show trypanosomes in some cases and are doing badly.

Amongst the new settlers is a headman, Luka, who has busied himself to attract men to settle with him, and there can be no doubt but that a sound first step in reconquering country from fly is to replace in their old neighbourhoods the headmen who have been driven out by it.

The chief measure which was applied this year to the block cut off was late burning, and Mr. Teare reported it to be still very free from fly two months later. The clearing might have been widened, for the provision of ground on which cattle can be kept may prove to be even a better inducement to settlement than assistance with cotton-growing; but this view is now being tested sufficiently elsewhere as the result of this year's clearings.

VII.—Progressive Annual Demolition of the Fly-belt by means of Clearing.

At a meeting of natives called for me at Kizumbi in November 1923, by Mr. McMahon, the Administrative Officer, the question discussed was the advance of the tsetse. I pointed out most strongly that they had the remedy in their own hands, and that a clearing each year of the young bush in the margins of the settled areas would save the situation, and, with Mr. McMahon, I urged them to make the effort. Many natives spoke in reply.

Each speaker re-emphasised the fact of the rapid and progressive disappearance of the cattle-country and population before the fly, the consequent extreme inadequacy of the grazing, and the urgent need for measures. (Wamba's population is said to have been reduced in this way from 30,000 to little more than 3,000.) All agreed that the real measure was the cutting down each year of this young bush on the margins, but stated that they had never had the combination to deal with it. To obtain this they needed an order from the Government or their Sultans, and they asked for such an order, as without it organisation was impossible.

Individuals spoken to on various occasions always stated the same views, and at a representative meeting of Sultans and natives called to meet me in Shinyanga by Major Scupham in May 1924, it was decided unanimously that the first of the projected annual clearings should be attempted at once. I personally allocated and supervised the work in the field with the aid of Mr. Teare, and in apportioning it regard was had in each case (*a*) to the nature and amount of the bush, (*b*) to the population of the Sultanate.

The people came out well. Sultans Ikombe, Makwaia, Makolo and Luhende brought 4,500 men to Kizumbi ; the four western Sultans 2,000 men to the road-barrier (Samuye-Kizumbi) ; and Mahizi and Masanja 1,400 men to the clearing of the margins of their own areas (Seke and Mondo) in the north-east. A number of the earlier workers fell out later and others came in, and clearing took place also at Nzega, so that, in all, more than ten thousand men engaged in these operations.

As regards the spirit of the people, it may be said that this was most striking. They worked with a will, sang at their work, were full of demonstrations of friendliness, and at any word of encouragement hacked with re-doubled energy or indulged in wild demonstrations. Nightly dances were the rule, at some camps in particular. Several times, going amongst them when at work, I was thanked by individuals, both commoners and headmen, for the additions to their grazing, and access to new waters, some of which were already being utilised by their cattle, and " tunafurahi sana " (we are very glad) was a common expression.

A dozen Sultans participated. Of these Ikombe and Makwaia deserve special commendation. The latter spent some days at a time in camp and made fighting speeches to his people in which the tsetse was described as the enemy, and themselves as soldiers in action. Ikombe, even better, never left the line of the cutters and continually encouraged his people with like similes. The response in each case was magnificent. The organisation in these two camps perhaps surpassed that of any other Sultan, though all were good, and the blacksmiths' and handle-makers' shops, ready at once to replace a broken tool, and the commissariat arrangements, were of a model nature.

Of the other Sultans who showed their keen personal interest by remaining in the field may be mentioned, especially, poor, blind Masanja, of Mondo, who, despite his infirmity, never left his workers. Makolo, Mahizi and, till she went to Samuye in connection with the railway survey, the Sultaness Nzile, come into the same category. Wamba, one of the model chiefs of the Territory, who was held in reserve, was splendidly helpful meantime in many ways to myself and in the matter of stepping into a gap when supplies ran short. Luhende was sick, but his people (of Uduhe) turned out in special force (1,300) and, under their leader Karomo, were amongst the hardest and cheeriest of the workers, even when they were for a day or two short of rations through the non-arrival of their supplies.

In general, the work done was astounding and could only have been the result of real interest. The lessons learned as to management will be recounted in Section xiii.

The immediate results of the work have been these :—

(1) The clearing of the great Kizumbi " bay " in the fly bush (see Map), said formerly to have carried 5,000 head of cattle. The bush was mostly thin and young, abandonment having been recent, but there were patches and whole woods of older growth, which entailed heavy cutting (Pl. xi, fig. 1). Nearly all had been infested in lesser or greater degree, and only one wood was left—Ngasa's, completely isolated by the clearing, in which even previously flies were so scarce that over 700 head of cattle were still kept in it. This clearing has given the natives grazing for many cattle, and provided a site, with ample grass, for their new ploughing school.

(2) The clearing (see Map), to a width of 400 yards on each side and a length of seven miles, of the road connecting the western with the eastern Sultanates. This had for some weeks been completely clear of fly when I left in October, and it should provide a safe passage from the first-named Sultanates to the ginnery, and for transport and the passage of cattle generally. The work comprised (and must always comprise) not merely felling, but the cutting up, dragging and piling of the trees for burning. Without burning of the felled trees there would be no hope of freeing the road from fly, and there was also a very necessary re-piling and re-burning of the débris after the first fire. The nearest piles to the road were a hundred yards away, and while, before they were burned, people drew very few fly and cars drew none (possibly a matter of greater difficulty in overtaking them with this extra start), cattle generally drew a few. The clearing of this strip of land was advantageous also in respects to be referred to in Sections IV and V below.

(3) Many square miles of grazing were reclaimed, and the fly-harbouring bush was pushed well back on the margins of the Seke and Mondo fly-bush and opposite Mwadui and South Usiha (see Map).

A general point to be noted is that the natives were not content with mere marginal clearing of the youngest bush. In each case in which the choice was left entirely to themselves they selected and cleared a solid block and thus gained at once a piece of grazing worth having. Another result of this clearing of a block at a time was that in a few cases its former inhabitants, driven out by the fly, were already, when I left, beginning to return to it. This was particularly gratifying.

Theoretically, a population which followed up its clearings might advance to an indefinite extent through tsetse-infested bush, leaving the latter to grow up cleansed, a safe number of miles behind the advance. But tribal and Sultanate boundaries will interfere, and even within these more limited areas very close supervision would be needed for safety.

So that, using clearing measures alone, it will probably be unsafe to clear more than we can definitely consolidate.

VIII.—The Breaking-up of the Fly-belt.

The Samuye road clearing, made permanent by stumping and widened, will form a useful nucleus for a renewal of the old break between the northern and southern bush-area, so that if by any chance we should succeed in clearing the southern area of fly, it may be possible to prevent it from being re-infested. The completion of this barrier will come about if we should clear really widely also the Kidalu River line, some miles north of the Samuye road. The work will be slight, for it is partly clear already, owing to the fact that its people clung to its good soils and the proximity of water to a late date.

The block contained between this Kidalu line and the road contains relatively few breeding places and much *Acacia spirocarpa*, large trees of which species can be killed completely by mere ring-barking (as in Pl. xiii, fig. 2), so that there is a hope that we may be able to cleanse it of fly with little labour and keep it clear by isolating it as I have suggested above. In that event the entire break would become so wide as to be of some real use. In any case, if the railway follows the Kidalu, as is expected, it will be well that the vicinity of the line should be clear, so that the trains may not carry fly into or through the cattle-country of Kizumbi.

My further immediate plans for the breaking-up of the fly-belt about Shinyanga are shown clearly in the map.

IX.—The Localisation of large-scale Cotton Cultivation in the Fly-belt.

I have long advocated (*cf.* Bull. Ent. Res., xi, 1921, p. 375) the localisation of large-scale agricultural enterprise generally in the fly-bush, (*a*) for its consolidating effect, if ploughing be used—for then it is necessary to draw the stumps ; (*b*) in the case of Shinyanga, to avoid the intensification of the congestion of the cattle, to which the diversion of still more grazing to cultivation could not but contribute.

The Shinyanga sub-district is, as I have said, the scene of an intensive effort to induce the natives the produce cotton on a great scale, and the very sound principle I have referred to above was fully agreed to in a conference at Tabora between the Senior Commissioner, the Acting Director of Agriculture (Mr. Wolfe), Mr. McMahon (outgoing Administrative Officer, Shinyanga), and myself. The conference was called by the first-named officer (Mr. Stiebel), and, as the result of the scheme brought forward by him, a loan of £7,000 was asked for, for stumping and ploughs, and has been secured. It will finance the Shinyanga agricultural operations generally, but as much of these as possible will be located in the clearings which have been made or will be made for the control of the tsetse.

The first large effort is being localised along the Samuye-Kizumbi road, owing to its exceptionally excellent soil, the fact that it has to be cleared in any case for the passage of ox-wagons, and its proximity to the Department of Agriculture's new ploughing school at Kizumbi. Further, the Samuye end of the road was selected for a second ploughing school which became necessary and which was also cleared in order that the practice ploughing at both schools might take place as far as possible along the cleared road. Many of the people of Sultan Wamba, and at its Samuye end those of the Sultaness Nzile, will locate their cotton fields in the seven-mile strip that forms the stem of this dumb-bell-shaped clearing connecting the two big culture steppes. Stumping was in progress under Mr. Teare's supervision when I last received a report, tools having been provided for stumping that were more effective than those the natives possess ; and it only remained to consider the utility of adding labour-saving apparatus for the lifting of stumps. A slight widening of the clearing accomplished already may prove necessary in order to render ploughing possible even as a 200 yards strip, but this point also is the subject of present experiment. Elands will give trouble and will have to be dealt with till settlement comes in (as it will) and excludes them.

A joint journey undertaken by Mr. Wolfe and myself to the various clearings, and a joint choice of the patches to be ploughed for cotton, gave us excellent evidence of the value of this co-operation between the Agricultural and the "Tsetse" Departments. The contribution to consolidation that the former will make will be small in relation to the size of the areas cleared by the latter, but valuable. The opening up of new cotton areas by the clearings will, on the other hand, be invaluable both to the first-named department, by giving access to the best cotton land, and especially to the Veterinary Department, for nearly every yard reclaimed will be excellent grazing.

X.—Other Measures for making Clearings permanent.

Much clearing of bush along roads was done by the Germans, and not a little has been done here and there by our own Administrative Officers. But there has been no continuity of policy in this respect ; the shoots have been allowed to grow again from the stumps, and the coppice thus produced from them has been a more dangerous harbour for the tsetse, and the logs lying on the ground have supplied more suitable breeding places than existed there before. Lamborn has remarked already on this effect of unmaintained clearing (Bull. Ent. Res. vi, 1915, p. 259).

Clearing must be consolidated. There are several ways in which contributions to this end may be made, and experiments in these are being conducted at Shinyanga.

One method of consolidating is to settle the area with natives in such numbers that they will automatically maintain culture steppe conditions by their cutting for timber and firewood, their shifting cultivation and by the browsing of their live-stock. Yet, again, it is possible (and the natives seem very prepared to respond) to order that all villagers in culture steppe should keep down re-growth from stumps by slashing back the shoots once or twice a year for a few hundred yards round their village. This custom we are inaugurating in Shinyanga, and it should be most useful.

The value of goats in this connexion has been referred to already. Native goats are liable to various ailments and do well only in smallish flocks, so that the villages to which they are attached must be fairly numerous on the ground for these animals to exercise their full effect on the bush. With these reservations there is no reason why goats should not do for us much of the magnificent and most striking work in keeping down bush that was performed on the Sesse Islands in Lake Victoria by the situtungas during the fourteen years of depopulation there, the entire absence of human beings having enabled the antelopes to increase their numbers sufficiently to become effective. In point of fact, goats do already perform this service in many places, but special encouragement requires to be given to the keeping of them just outside the margins of the fly-bush or in areas specially cleared. The fact that, as regards trypanosomiasis, the goats we distributed to villages in the fly have done so well is encouraging, but a period of poverty might result here also in as great a loss as took place in our main herd. Capt. Hornby, our Veterinary Pathologist, is interesting himself particularly in this question.

Unfortunately, all three of the above measures, valuable as they are, depend on the presence of population or its influx in sufficient numbers into the areas we clear; and we cannot, without great care, thin out, beyond a certain point, the people who are holding a particular area already, without robbing Peter to pay Paul, and letting the tsetse in in their rear. We can, however, by adding to the usual effects produced by human occupation, increase very greatly the area that a particular population is capable of holding, *e.g.*, by inducing them to cut down the sprouting bush and to keep more goats; and we can, by watching for congestion of population, due to natural increase or other causes, and by encouragement of dispersal where congestion is commencing, keep going a continual encroachment on the tsetse-infested country in place of the present unregulated fluctuation of expansion and retreat, which operates very greatly in favour of the tsetse.

Measures that will kill the bush completely or replace it in parts by valuable high timber forest, which in East Africa is little favoured by the fly, are those we must specially seek for; for the tsetse-haunted bush is in general very useless, whether from the point of view of soil-conservation, water-conservation, timber, or any conceivable effect on the rainfall. In clearing, the more valuable species for timber and fencing—as *Afzelia cuanzensis* (mkola and mkongo), *Burkea africana* (mkarati), *Afrormosia angolensis* (mwhanga), *Acacia pallens* and *nigrescens* (mkambala), and one or two species of *Pterocarpus* (mninga, etc.)—might very well be left, for they will not by themselves continue indefinitely to harbour tsetse, and, in any case, the removal of only certain elements in the bush will generally suffice to clear a particular piece of country of a particular species of tsetse-fly.

Touching, therefore, on the measures that will kill bush finally, I may enumerate first the localisation in tsetse areas of agricultural projects entailing ploughing. What we are doing in this connexion has been sufficiently described already.

Secondly, in a report (unpublished) on Nzega, I have described how the natives of Makarundi have made a large proportion of their culture steppe permanently safe by systematically digging up the stumps for firewood instead of making long journeys to the bush for the latter. This has happened in parts of the great Mwanza culture steppe also, and it should be made the rule in all such areas. Sultan Makwaia has

agreed gradually to institute such a rule in his country during the rains, when the stumps are easy to unearth. Against the time when the natives of a large culture steppe, like those of Makarundi and Mwanza, will have finally to travel to the bush after having more or less finished their stumps, the Forestry Department should guide them in the making of plantations, which, provided that they were closely planted and thus rendered unsuitable for the fly, could not harbour tsetses even were they carried back into them.

Thirdly, poisons that will kill woody growth may be considered and, if cheap, be used. Experiments with arsenite of soda have already been described (Bull. Ent. Res. xi, 1921, p. 380), and others were subsequently carried out. A certain number of trees were killed and others weakened, but I did not consider the method entirely satisfactory as regards either cost or results. I am at present experimenting at Kilosa and Shinyanga with saltpetre, which, inserted into an auger-hole that is then plugged, is stated gradually to kill the tree. The latter, permeated with the saltpetre, should after some months burn out to the very tips of its roots and of its twigs. It has to be seen whether our bush trees, extremely tenacious as they are of life, will be able to resist its action. Experiments with other chemicals are being attempted also.

Finally, before the great grass-burning this year, experiments were made near Kizumbi in particular modes of ring-barking, and as there is evidence that a particular species ring-barked, cut down or otherwise maltreated in particular months is more likely to die than it would be under the same treatment in other months, experimentation in relation to each species of importance will be carried out (*cf.* Pl. xiii, fig. 2).

XI.—Means of Preventing the Flies from being carried by People and Game into Cattle Country.

Such means have been tested at the Kizumbi (Wamba's) end of the "dumb-bell" clearing, it having been specially necessary to protect this great bay, the site of the first and most important of the two ploughing schools, from any influx of fly.

It may be said here that all the evidence in Shinyanga was to the effect that the infestation of more and more country by the fly was due in the main to the carrying of the fly by man; also that clearing is only the first stage in the process of expelling the flies from a piece of country, for they continue to be carried into and to lodge in the lying timber. The entire process (as actually carried out at Kizumbi), if the fly is to be banished completely and with rapidity, is this: (*a*) clearing; (*b*) an investigation lasting over some weeks, with bait-cattle wandering and fly-boys variously stationed, to ascertain fully and accurately the new position as regards infestation; and (*c*) the application of the supplementary measures indicated by this investigation.

The measures finally adopted were as follows:—

The actual grazing was put out of bounds except to people of the villages in the open country, who were given passes; fly-boys were stationed on the main road to clear motors and wayfarers entering the area; certain redundant paths were closed; direct passage between the infested bush and the pasture of the ploughing school was forbidden, and if building material had to be fetched from the former, it was first stacked outside the bush and, on a second journey, the flies having returned to the bush, brought thence; game in so far as possible was excluded by shooting; and, experimentally and after consultation with the native cattle-owners, who were in favour of it, people were forbidden to allow tsetse-flies to travel on their persons.

The latter measure is capable of extended application, one or two guards being placed in each area to keep it enforced; and it is pleasing to be able to record that at Kizumbi it at once proved successful and has continued to be so, people having

taken to clearing themselves of "following" flies and being able to do so in spite of the apparent tenacity of the insects. Several guards were necessary at first, but it proved possible to reduce them to two and even to use them at intervals only.

The foregoing work bears on the possibility of erecting barriers that the fly cannot cross, and my present view on barriers may be stated thus: A barrier must either be very wide indeed or there must be enough people settled in it to control the free passage of game, and the people themselves must be effectively subject to the regulation I have just referred to. The width has yet to be ascertained, but an uncleared wood at Kizumbi that is about 1,900 yards from the nearest infested bush is running successfully several hundred cattle, and we are able to find only an occasional fly therein. Such flies have probably not been a recent introduction. This wood will be watched throughout the year.

At the fly stations at which cars and persons were cleared of flies, a difficulty arose from the fact that some of the flies would fly to the ground all round when the car or person stopped, and escape the fly-boys' notice. One or two of them would then rejoin their carriers when these had moved on a few yards and continue their journey. It did not seem that the fly-boys could be relied on always to move on these few yards while catching, so two small verandah-like sheds were erected, one on each side, facing each other across the road. These were found quite useful in attracting and detaining the flies that would otherwise have gone on and evaded capture.

XII.—Late Grass-Burning.

Some years ago, as the result of many years of annual personal experience of grass-burning in different months for pasture purposes and for the protection of rain forest, in Rhodesia and Portuguese East Africa, I strongly recommended to the Tanganyika Government that early, harmful burning of the grass should be prohibited, and that well regulated grass fires should then be lighted late in the season as an aid to the control of tsetse and other vermin.

A small and very promising experiment was also carried out near Kilosa, in 1921, but it was only in 1924 that I was able to devote myself personally in Tanganyika to the preservation from burning of more than a small area of fly-bush and the organisation for burning it afterwards, though the policy has now been in force in the Territory since 1921, and has been not unsatisfactory in its results, where the Administrative Officer has been able to give it the considerable attention necessary to success.

Further, a missionary, Father Cirvegna, has most kindly taken it up and obtained from it the results which are described below.

My own larger experiment was as follows :—

An infested bush-area that is half in the Nzega, half in the Shinyanga sub-district, was preserved from early burning in 1924. It measures about seventy miles in length, about forty in maximum width, and perhaps 1,700 square miles in total extent. It shrinks to a "waist" of seven miles only on the Kizumbi-Samuye road.

This area is subdivisible into three sections: that of Nzega, from "Stoke's Camp" (see Map) northward to the Manonga River; the Samuye section, stretching thence to the Kizumbi-Samuye road; and the Mantine section—from that road to a line north of the Mantine hills and of Shinyanga. Beyond this line, the country was burned off by fires from Mwanza and the unpatrolled country of Nindo.

Areas of *Brachystegia-Berlinia* bush (miombo) were involved in the Nzega section. The rest was *Acacia* and *Commiphora*. Three tsetse were present—*G. morsitans* in the Nzega section, *G. swynnertoni* in the portion of Nzega near Mount Kisuge (an area it has invaded recently), as also throughout the Samuye and Mantine sections; and *G. pallidipes* in small numbers in a part of the Mantine section.

The prevention of the grass from burning.—When I arrived in the district late in May, the grass had already been dry enough to burn for some time owing to the extraordinarily early cessation of the rains, and the smoke of illicit fires was to be seen daily in various directions. With the keen and invaluable aid of the Administrative Officer in Charge, Major Scupham, control was at once organised. Guards were appointed, each with an area, and (through Major Scupham) the aid of the Sultans and headmen was enlisted.

At first many burners were brought in, but in five days smoke had ceased as though by magic. After that we had in the Shinyanga sub-district only a rare fire, and all but one of these two or three fires (that of unpatrolled Nindo) was extinguished with the aid of the natives.

Plan of Burning.—If it be badly lighted, badly organised, or lighted on an unsuitable day, or if it should burn at night or grass be lacking, even a late grass-fire may be quite as useless as an early one. It was arranged to burn this fire with the prevalent south-east wind, first in Nzega, then (immediately on the fire reaching the Manonga River) in Samuye, and then continuing across the Kizumbi-Samuye road, through the Mantine Country. The hundreds of natives who, well spaced, would be engaged in putting in the fire, were to follow it to the very end of their respective sections and light it afresh wherever it might be interrupted by a path or a sand river, ill-grassed ground or grassless thicket country. They were camped beforehand at points along the line of commencement and interspaced with water-carriers, and, so far as possible, but necessarily at wide intervals, with responsible natives in the employ of the Government.

It was hoped to test the view that if the great majority of the thickets were burned through, the fire (if generally fierce) would constitute a " drive " of the fly and a drive of the game, and that, should the latter not be tempted to return at once to the burnt-out area, hunger might be added to the inconveniences to which it was proposed to expose the fly. It was hoped also to destroy much of the smaller woody vegetation through the special fierceness of so late a fire and, where the thickets were burned, a proportion each year of the pupae and of the breeding thickets themselves. A piece of ground was held in reserve north of Shinyanga for the further testing of any conclusion the main fire might suggest.

Subsidiary Experimentation.—Four subsidiary experiments of possible future importance were attempted.

One was an experiment in basal ring-barking of trees, to be followed by the burning.

In the second experiment a large thicket of a type into which it was anticipated that the grass-fire would not enter was littered with grass. The latter was so dry that ample could be plucked with ease and speed with the unarmed hands. This experiment had been successful on a similar small scale three years ago in Kilosa, the thicket to which it was then applied being still to-day non-existent (Pl. xv, figs. 1 and 2). After the big fire last year in Shinyanga, this experiment was extended to more than a square mile in the reserved patch. The process is speedier and cheaper than cutting down.

In the third experiment (confined to the Lubaga experimental block) the breeding thickets were cut down.

In the fourth the effect of " rat-varnish," attached to people and to screens, was tried as an aid to the extermination of the fly in some of the places to which the fire drove it, the effect hoped for being that of bird-lime.

Description of the Fire.—The Nzega fire, put in on a forty-mile front, burned magnificently and produced the excellent results to be described as having been obtained from the Mantine fire also.

The fire reached the Manonga late in the day,.and in consequence the northern two-thirds of the Samuye section burned at night.

Like all night fires, this fire was not a success, it divided and went forward in tongues which then converged from their sides, burning badly through not travelling in front of the wind. Few or no thickets were burned through and the distribution of the fly was not greatly altered.

The lesson to be learned was that we had attempted too much for one day. For future fires the Manonga is to be completed as a fire-break and made the limit of the first day's burning.

The Mantine section was burned on the following day (8th September).

The fire went with a roar and a sweep, except near Shinyanga, where a headman and his people failed to fulfil their rôle. Elsewhere it was duly followed up by the burners for a number of miles, and in this area, as in Nzega, great numbers even of grassless breeding thickets were burned clean through.

Results of the Fire.—The effect of a drive appeared to have been obtained over a fair proportion of the two large sections that were burned according to plan—Nzega and Mantine. The fly was absent from considerable extents of ground on which it had previously been pestiferous in its attentions, and even a month after the fire it was possible to go over these without attracting a single fly, or, it might be, no more than one or two in the course of a considerable walk. Bait cattle working over areas in which they could previously count on taking fifty or sixty flies in an hour, or were assailed by more than this number at once, would come back with a total bag of eight, ten or twelve flies for the day. Mr. Teare, reporting on these areas two months after the fire, stated that the flies remained exceedingly scarce.

Wherever appreciable grassless thickets or thicket-clusters had not been burned through (and there were still, in places, many such), and in a piece of ground burned early in spite of us, flies continued to be present, and in the latter and the more important of the former we found them collected in vastly greater numbers after the fire than before it, having obviously been driven into these places. We had not the material to deal with all these collections, but 19,927 flies were caught in one of the two collections that were dealt with experimentally. In the smaller of the unburned thickets only an occasional fly was found.

Beyond the limit of the Mantine fire, along the borders of the ground burned earlier from Mwanza and Nindo, Mr. Teare found flies after the fire in incredible numbers, and was attacked with great voracity. He had to cover his knees and was laid up the next day with a temperature which he attributed, probably rightly, to this biting. He had been there a few days before the fire and found relatively few flies.

In short, it appeared that the effect of the fire had been to drive the flies into limited pieces of ground, on which if I had had in time several hundreds of nets I could probably have exterminated them, at least over a very considerable patch of country.

No evidence could be obtained of any breaking back over the flames on the part of the fly in the case of the fires which burned by day under suitable wind conditions.

For the burning of the reserve patch I was unable in the few days at my disposal to obtain suitable weather conditions, and the drive effect was only obtained locally, but quite markedly, for 15,097 flies were taken by Mr. Teare in one of the concentrations in this patch after my departure. The date being late and rain imminent, the wind on the day of burning was a light and variable air which came in turn from every quarter of the compass and often dropped completely. It has already been stated that the fire late at night failed to produce the effect of a drive. It may be added that the following up by the burners was not obtained into the night, nor was it obtained adequately in the reserved patch, the fire being for the most part so mild and changeable, in sympathy with the wind, as to encourage the men to slip in front of it and take to hunting francolins, while the flames were frequently so low that there was nothing to prevent the fly from crossing back freely, and there was reason to believe that it did so. Altogether it formed an excellent control to the main experiment.

Effect on the Game.—Everywhere the game went in front of the fire. Subsequent observations were carried out on the game in the Mantine area in particular. Some elands and impala slipped out into the Kizumbi culture steppe during the lighting, but the game generally was found in very greatly increased numbers afterwards in the country burned long previously north of Mantine. There was, however, little grazing there or for a great distance beyond, so that within a month after our fire, though no grass had yet grown or leaves shot out, fair numbers of animals were found lying up in the more lately burned bush in the day-time and coming out at night into the margins of the Kizumbi culture steppe to feed in the unburned grass and the cotton fields from which the crop had been harvested. This applied even to giraffe.

In spite of this presence of a good deal of game, the scarcity of fly to which I have referred continued, and it seems not unlikely that a divorce of the game from the fly could be perpetuated if we could eliminate more thoroughly than we were able to do this year, with limited material, the flies in the foci into which they were congregated by the fire. Wart-hogs shot by Mr. Teare seven weeks after the fire were found to be carrying flies in the badly burned locality near Shinyanga that I have mentioned already. Impala were shot in five other localities and no flies were found on them. In each case this was some weeks after the fire.

Effect on the Breeding Thickets and Logs.—An immense number of small grassless thickets were burned right through and it already seems certain that a very large number even of unlittered thickets have been destroyed to the ground. A number of lying logs also were consumed. Both these are effects which the earlier fires do not not produce. Of the thickets that were adequately littered with grass it is doubtful if many will continue to be thickets.

Effect on the Pupae.—Out of 44 of the unemerged pupae taken from the thickets, littered and otherwise, which had been burned through, 23 (or 52 per cent.) were definitely dead, and some showed actual scorching. In the better-littered thickets the ground was sometimes too hot to touch with the hand at from two to three inches below the surface for a short time after the fire. The pupae were practically never found more than an inch, and seldom more than half an inch, below it. Of 48 pupae found in thickets (in the same patch of ground) which did not burn, only four (about 9 per cent.) were dead, from other causes.

With regard to the proportions referred to above it must be added that the pupae were searched for the day after the fire and those that were still full-weight a few days later were judged to be alive. Had they been left out under the conditions of exposure produced by the fire, a larger proportion would probably have succumbed.

It took much searching to find these pupae, though empty shells were found in very great numbers. The breeding of the fly up to the date of the burning had certainly not been going strongly even where the flies were abundant, so much so that it had often been the subject of surprised comment by my fly-boys. Lloyd and Johnson's recently published view (Bull. Ent. Res. xv, p. 25) that late burning will be useful also in prolonging long-grass conditions inimical to breeding was, to this extent, borne out.

Effect on the Bush generally.—Where the fire burned at night or (as in the reserve patch) with little wind, or in the very short grass of which patches besprinkle the fly-belt, its effect on woody growth was small or nil. Where the grass was longer and the other conditions right, a great deal of damage to the smaller woody growth has come about. Much or most of this will doubtless shoot again from the roots, though a proportion of the shoots tend to die, but subsequent fires will more easily burn them back, and if we should expel the tsetse meantime, either with the aid of this over-ground thinning of bush and thickets or by some other means, it will not matter, except to grazing, if the thickets grow up again later.

The Position more than Two Months after the Fire.—Mr. Teare reports, under date 14th November, that very few fly could even then be found in the neighbourhood of

Kizumbi, and that the daily catch at the "fly-station" at Lubaga for the clearing of passers-by had for November averaged four. This may be contrasted with over one thousand flies caught at that station in the first fourteen days of July. I have not the subsequent figures by me, and this is certainly rather higher than the average half-monthly bag, but the effect of the fire was sudden and marked, and it was demonstrated that practically all flies that were afterwards caught on the road at Lubaga came from an early-burned patch of ground further along that had already been attracting fly, but that now formed a vastly more crowded fly concentration than before and became the site of organised catching by ourselves.

That fly should have remained scarce up to two months after the burning surprised me, nevertheless, and, for the reason I shall give in Section XIV, I doubt if this position will long continue.

Effect of the Rat Varnish.—This on cars and natives was very successful during the first hour after its application, and I am arranging to placard all passing cars with sheets of brown paper smeared with it and to turn into "sandwich men" also many of the natives who pass along the road. It might prove possible in this way to keep much-travelled roads sufficiently clear of fly to enable cattle to travel with only slight loss.

That the varnish should be useful in connection with the extermination of the flies when concentrated after the fire was proved by Mr. Teare when dealing with the concentration in the reserve patch. Far greater success was obtained by placing it on the backs of natives than on moving and stationary screens.*

A skin soon forms which in an hour spoils the effect of the varnish, but is capable of being broken up with a stick a few times before final drying takes place. This tendency can perhaps be counteracted by less boiling of the varnish.

XIII.—Lessons from the Clearing Experiment.

I have regarded this first clearing as an experiment and a demonstration. An experiment to test the spirit of the people, the possibility of making a few days' clearing an annual event, and the best methods to adopt; a demonstration to the people themselves of their power to beat back the fly. I constantly visited the various working contingents, watched the work, went from group to group chatting individually with the workers, and I visited some of their camps.

I have referred already to the excellent spirit of the people, both commons and chiefs. It is certain that with tact and good organisation they can be guided themselves gradually to push back, break up and demolish the tsetse belt. This can only be done gradually, for the work must be consolidated as it proceeds. Other conclusions were also arrived at. Thus, the fact that set tasks were attempted (at the natives' own request) prolonged the work of certain contingents to a month, while others finished earlier. Two contingents who finished in a fortnight volunteered spontaneously for a further piece of work chosen by themselves. In those that worked a month interest had very definitely flagged, and it flagged more easily also in the cases in which the Sultan did not himself attend to encourage and to organise. The people of Uduhe, under good alternative leadership, were an exception.

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* Mr. Teare reported: "The varnish when smeared on cardboard or thick paper and carried on backs of natives was successful, up to ninety-six flies being caught on one boy. A moving target that was being dragged between two stationary posts only succeeded in catching two flies. Dummy donkey attracted and caught ten." It must be remembered that this fly is more of a man-eater than *G. pallidipes* of Zululand, on which Mr. R. W. Harris, the local Tsetse Investigator, used the first and original dummy donkey.

The following, then, are the right lines on which to work in the future :—

(1). As great a number as possible from each Sultanate concerned should be encouraged to come out *at the start*, not 10,000 in all, but 20,000 or 30,000.

(2). Once together, they should not be given set tasks of any great magnitude, but seeing that they always ask for a set task, they may be given clearing that will not take more than fifteen days and then, at latest, be sent home. Thus they will not tire of the work or lose enthusiasm.

(3). Each Sultanate should, so far as possible, clear ground that is needed for its own cattle on those portions of its line that it will select in consultation with ourselves. I say " so far as possible " as I know that some of the Sultans feel and are willing that assistance should be of an all-round nature—a general attack by all each year on some particular section of the problem ; and that is certainly a feeling to be encouraged.

(4). The outing should be made as much of a picnic and jollification as possible, the Government contributing meat liberally. Also the work must be treated as a campaign, with Sultans and headmen in leadership and with perfect organisation by themselves. On no account must it degenerate into mere mechanical gang-work.

(5). So far as possible, every clearing should be made demonstrably to subserve, directly or indirectly, the purpose of the reclamation or safeguarding of grazing. This and the pushing back of the tsetse the people thoroughly understand, appreciate and want.

(6). We started late. All the people now agree that April is the month in which they can come forward without any disturbance to their other work. A failure to follow this preference may lead to economic disorganisation and unpopularity.

XIV.—Lessons from the Burning Experiment.

It was shown :—

(1). That with good organisation and European supervision it is perfectly possible, even in a first year and with natives unused to a strict enforcement of the measure, to preserve successfully from early burning a great extent of tsetse-infested bush. Native guards should be appointed and kept up to the mark, and their leaders supplied with bicycles ; the co-operation of the headmen and cattle-owners must be enlisted and lighters of unauthorised fires be punished without fail.

(2). That the burning must take place while the steady east winds can still be counted on, *i.e.*, in Shinyanga, in September. The wind should be strong on the day itself and the sun hot.

(3). That, to avoid late night burning, which is nearly useless, the belt to be burned must be divided into blocks not more than 20 miles wide, and preferably less, convenient rivers and roads being reinforced by fire-breaks (burnt earlier in the year) to enable them to bring each day's fire to a stand-still. In the fire itself the windward block should be burned first, and so on, a block each day, to the furthest end of the area saved.

(4). That, to obtain complete success in burning so large an extent of country as that which I burned last year, it is necessary for the supervisor (*a*) to employ a large number of natives ; (*b*) to have a motor bicycle and paths on which to use it ; (*c*) to keep under his hand, in reserve, at least a hundred natives and a few good native leaders and messengers with bicycles and to use them to meet the unexpected interferences with his plans which are bound to occur sometimes.

(5). That fire-breaks should be completed well beforehand—(*a*) for the protection of grazing along the margin of cattle country ; (*b*) to prevent the fire, and with it the fly, from passing from infested bush into bush as yet uninfested. This possibility had

to be planned against in the Shinyanga-Nzega area, and was successfully circumvented. It is probable that the ordinary unorganised grass-fires help to spread the tsetse thus every year.

(6). That the continuity in the line of the drive which is broken by extensive grassless thickets can, nevertheless, be maintained by littering these beforehand with grass, and that littering thus or clearing the thickets may prove the most economical direction into which to turn the efforts of the thousands of natives who will, I hope, continue to turn out each year to drive back fly.*

In other words, it may not be necessary to cut down or ring-bark the whole bush. Destroying the thickets should theoretically suffice. In practice it becomes a matter, unless we have a barrier up to which to work, of preventing the flies from being carried in again from the country beyond that is as yet unaffected by our measures. And here I may say that I have no expectation that the recent experimental fire will have any continuing effect on the distribution of the tsetse in the area burned ; because, owing to a sufficient sprinkling of unburned thickets, the proximity of the places burned earlier in the year, and the fact that I had not enough nets and bird-lime to deal with the fly in all these places, it has nowhere been driven off or exterminated to a really great distance, and sooner or later the game, or the game and man, will distribute it again. Still, it would appear from all the results obtained that we may find late grass-burning to be a really useful measure, if carried out in suitable weather, and if thoroughly well organised and combined with a previous destruction of all possible thickets of any extent and a subsequent thorough campaign on the lines adopted by the Portuguese in the island of Principe against the concentrations of flies that are still brought about by the fire.

In corroboration of this last view, I may quote Father Cirvegna's experiment, to the satisfactory results of which I have already alluded cursorily. My first intimation of his success had been a letter in which he stated that by means of repeatedly postponed and organised grass-burning he had cleared of tsetse the fly area at Madibira, in the Iringa district, and that the natives had already brought in their cattle and were using the area for grazing. On my proposing to proceed to Madibira somewhat later, I was told that he had gone to Europe and that I should get little information worth having till his return.

Fortunately I travelled to England subsequently with the Administrative Officer of the sub-district, Mr. K. F. Warner, and he has given me, subject to correction by Father Cirvegna when I can get in touch with him, the following account :—

The Father enlisted the interest of the natives and succeeded for three years in succession in holding up grass-burning in an area a dozen miles in diameter, part of the tsetse belt near his mission. He burned each October in an organised fashion, and, as in my burning near Shinyanga, the flies (*G. morsitans* in this case) were concentrated by the fire in unburned places, notably some reed beds. His school-boys caught him the flies in these reed beds for rewards—in the first year some thousands, in the second year, say, half the original number, and in the third year only very few flies, no more being obtainable. The area had apparently been cleared completely of tsetse and the natives brought in their cattle as stated, and have continued to graze them there.

They are so impressed, Mr. Warner tells me, with this success that they are most anxious to co-operate in extending the area. This, and the effect on Mr. Warner

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* There is one objection to " littering "—the considerable trampling of the grass that takes place during this operation between the thickets wherever the latter are very numerous, and a consequent lessening in these places of the general fierceness of the fire such as may allow some of the fly to break back, though probably far fewer than would have remained in the unburned thickets. It is likely, in any case, that any reduction in these places of the effect on the fly on the wing will be more than compensated by the destruction of its breeding places and pupae.

himself (for our Administrative Officers have been somewhat sceptical about the measure), once more proves success to be the finest of propaganda. Mr. Warner tells me that thickets are not abundant, he thinks, in the area treated (this may account for the rapid success), but are abundant in the country just beyond, as yet untreated and swarming with tsetse; but the proffered co-operation of the natives should facilitate the destruction of such of these thickets as will not burn.

Mr. Warner is completely satisfied that Father Cirvegna's measures, and nothing else, have caused the evacuation by the fly of this area, with which they coincided. Here, again, the prevention of re-infestation is going to be the real difficulty, and, except for the sake of the impression on the natives, I think it rash to put cattle in and so interfere with the burning until the fly has been pushed much further away.

XV.—The Application of the Lessons gained in Shinyanga to the Control of Tsetse elsewhere in the Territory.

In the bulk of the rest of the Territory there is no segregation of man from fly, and the natives live scattered through the infested bush. Their gardens are destroyed by elephants and eaten by various other mammalian pests; lacking combination and accessibility they and their stock are an easy prey to lions and leopards; they are inaccessible also to administration, medical treatment, education, and any efforts for agricultural development; they are bitten by tsetse in all their occupations, and are liable therefore to sleeping sickness when infection is introduced; and they cannot keep cattle, use them for dowry or transport, have milk for their children or plough.

The obvious remedy is the introduction elsewhere of the Usukuma mode of settlement (Pl. xiv, fig. 1). The people should be induced, gradually, to collect in these loose yet sufficiently closely dotted aggregations. As these keep the bush down sufficiently and produce culture steppe, their occupants should be induced to keep cattle, even being assisted by the Government to acquire and introduce them.* Once having become keen cattle-owners, they will be afraid to disperse lest they lose their stock, and will be as anxious as are the Wasukuma to hold back the tsetse and to reclaim, each year, grazing sufficient to provide for the increase of their cattle. Ultimately all would become cattle-owners, and control of the tsetse would, for all practical purposes, have become an accomplished fact, Further headway would be made with increase of population, and gradually, under guidance, settlements would coalesce, the tsetse-belt be more and more broken up, and any isolated blocks that failed to become free automatically could be treated individually.

Late organised grass-burning, if it fulfils its present promise, will push the control of the tsetse still further afield. It may even replace the other measures over the large areas that are suitable for it, but it is too early to say this with certainty.

There are considerable areas of more or less continuous thicket and of country that is for other reasons nearly grassless, and these either will not burn or will not burn fiercely enough, just as there are great areas in which, through lack of population, it will be impossible as yet to affect the tsetse by means of settlement or clearing. Where the thicket areas themselves already in most parts exclude grass-fires they may be converted, by sowing at stake or otherwise, to high forest such as, under our conditions, is little beloved of tsetse and is so much needed by the Territory.

By one method or another, depending on the nature of the country, I believe that we are now in a position to commence our attack on the tsetse. Research must go on side by side with our control measures (for these must still be largely experimental), and will no doubt produce discoveries that will assist them, but we know

* In the Kahama sub-district natives in new concentrations have already themselves begun to introduce cattle.

a very great deal already of tsetse bionomics, and it is, as I have stated before, only by tackling a particular infested area or Territory, and endeavouring by every possible means to bring its tsetse under control, that we shall, at this stage, make advances worth making in our knowledge of how to fight the pest ; and the difficulties we meet with in our fight must inspire our further research work.

Adequate staff, including both research and reclamation officers, the latter to work through the district Administration and with the co-operation of the Medical, Veterinary, Agricultural, Education and Game Departments, is very necessary to the success of this new method in our investigation of the tsetse problem.

XVI.—Summary.

1. Shinyanga is divisible into :

(a) Thorn-bush country containing plenty of tsetse but no population (Pl. x, figs. 1 and 2). This now covers far more country than it did fifty years ago, owing, first, to depopulation caused by natives wars, secondly, to depopulation caused in the past fifteen years by (chiefly) the advance of tsetse ; and its distribution has also changed greatly.

(b) Open grass-land, produced in the past from the thorn bush by the settlement in it of people in sufficient numbers to clear it and keep it clear through their cutting for firewood and building and the browsing of their stock (Pl. xi, fig. 2 ; Pl. xv, fig. 1).

2. Except in one respect the position in the open country is ideal. There is complete segregation of tsetse and people, and a situation exists in consequence amounting, for practical purposes, to control of the tsetse. All the people are able to keep cattle and all the children to get milk, tsetse are excluded, sleeping-sickness is excluded, and, owing to the compactness of settlement, mammalian pests are excluded except from the margins, and the people generally are accessible for purposes of administration, medical treatment, education, and agricultural development.

3. The exception is this. The tree roots still survive in the open country and, whenever population thins for a time, shoot up into bushes and trees. Where these are adjacent to tsetse bush, the fly is carried into them, while they are still small, on persons passing to and fro, and cattle begin to die. The people then fall back, allowing new bush to spring up and the process to be repeated. In Shinyanga this retreat and the reconquest by fly has been for some time at the rate of a mile a year, and new " fronts " have been formed, so that the cattle-areas are now nearly surrounded.

4. The position is serious and urgent. If it had not been taken in hand the cattle areas were doomed, as were the present schemes of development, and the railway now planned on the strength of the presence of population might have led ultimately to a depopulated waste.

5. The remedy is in the hands of the people themselves. They have merely each year to combine to cut back the young shoots and the bush and the tsetse cannot advance. And persons must not allow the flies to travel on them into cleared areas.

6. But the retreat, and natural increase of stock, have caused congestion of the cattle in the areas still populated, with severe shortage of grazing, and deaths ; and the destruction of grass has led to erosion and serious loss of soil (Pl. ix, figs. 1 and 2). The remedy is again easy. When the people come out each year to cut back the young shoots, they should take the opportunity to clear for some little distance into the bush and so get enough grazing. Also, any new agriculture likely to demand much ground, and so still further to reduce the grazing, should be located so far as possible in the fly-bush. All this was explained to the people, and they asked us to organise an effort on their part. This we did, in May and June 1924, when about ten thousand men went into camp under their respective Sultans and headmen and cleared in the

most energetic manner many square miles of tsetse bush on a great part of the Shinyanga tsetse "front." It only remains to organise this effort as a popular annual custom and to locate the clearings knowledgeably and in conformity with a thought-out plan in order gradually to break up and destroy the fly-belt. The lessons as to management that were learned from this year's clearing are detailed on p. 331.

7. A small, typical, infested block of the fly-bush has been cut off by clearing and an experiment initiated: (*a*) in inducing natives to settle in the barrier, so as to widen it automatically and keep it clear; (*b*) in clearing the block itself of fly; and (*c*) in testing the width of barrier which, combined with such precautions as may prove of use, will prevent the block from becoming reinfested from the main
/32 bush. The initial response to the inducements offered (p. [illegible]0) has been good.

8. The first step towards breaking up the fly-belt on a greater scale has been taken by clearing, to a width of 400 yards on either side, a road traversing a point (Samuye to Kizumbi) at which the fly-belt narrows to seven miles. It is planned to make (and greatly widen) further breaks and to attack in detail the blocks broken off, should it prove difficult otherwise to prevent reinfestation of country that may be cleared of fly by grass-burning, etc.

9. Felled bush continued to harbour fly for some time, at any rate if people and game continued to wander between it and the bush as yet unfelled. Complete destruction of the timber by twice piling and burning it made it uninhabitable by fly, but if time is of no account, the bush can lie till the twigs and small branches of it are warped downwards into a closer mass by the next rains and so are destroyed by the grass fires of the following year.

10. A direct prohibition, enforced by a patrolling guard here and there, reduced nearly to nothing the carrying of flies into cleared or cattle country by man. Game wandered in and out almost entirely at night. The stationing of a pair of fly-boys on a road with nets, combined ultimately with dark shelters alongside for the attraction of the flies, was most useful during an entire year in preventing the carrying in of flies by cars and wayfarers. The attachment of brown paper smeared with "rat varnish" to the hoods of cars and the backs of natives was useful in destroying flies frequenting a road.

11. Mere cutting of tsetse bush is useless, for it springs again, so that it is futile to try to gain ground by this means faster than we can consolidate it. The following measures for the consolidation of clearing are being tested now in Shinyanga: The introduction of native settlement to keep the ground clear automatically; the special cutting down once or twice a year by each village of the new shoots for a few hundred yards round; the encouragement of the keeping of goats; the diversion of large scale agriculture by ploughing, which entails stumping, to the clearings it is wished to consolidate; the digging up of stumps by the natives for firewood; and the killing of trees by poisons and particular forms of ring-barking.

12. The annual postponement of the grass fires till October, and then lighting them on an organised plan, was advocated some years ago (Bull. Ent. Res. xi, 1921, p. 382), and was encouraged by circular in Tanganyika Territory in 1921, when also I carried out a successful experiment near Kilosa (Pl. xv, figs. 1, 2). Father Cirvegna took up the organisation of the measure over a small piece of fly-belt at Madibira, in the Iringa district, and there seems to be little doubt that he has cleared the area of fly by means of it in three burnings.

A large scale experiment by myself this year in the Nzega and Shinyanga sub-districts seemed to show: (*a*) that by means of native guards, each with an area, and some aid from the headmen, it is perfectly possible to preserve a great piece of country nearly unburned; (*b*) that the late grass fire, lighted on a broad front with a good wind and followed up by the burners, produces, when the grass growth is sufficient, a "drive" of the flies on the wing; these then become congregated in enormous

numbers beyond the limits of the fire and in any appreciable patches of ground which escape it ; (*c*) that in these places, by the prompt use of nets and bird-lime, it is possible nearly to exterminate the congregated flies. The fewer these congregations the more practicable is this measure, so that the destruction of the more extensive fire-excluding thickets by hand will be a useful preliminary measure ; (*d*) that far more numerous breeding thickets and breeding logs are destroyed by such a fire than by an earlier or ill-organised fire, and that with the expenditure of some labour in the littering with dry grass of thickets and logs unlikely to be burned otherwise all may be burned, or many may be cleared by hand ; (*e*) that a much larger percentage of dead pupae (52 per cent. in this case) may be found afterwards in breeding places thus burned through than in those that are not burned (9 per cent.).

13. Some of these indications merely confirm results previously obtained by me in Rhodesia and Tanganyika ; others need to be confirmed by means of further experimentation. Meantime, combined with Cirvegna's result, they suggest that late organised grass burning is likely to be of value over the very considerable areas in Africa in which the grass and the dry season are long and organisation is possible. But even if this should definitely prove true, means of preventing reinfestation must be studied, for these may turn out to be a serious difficulty.

14. The relations of the fly and the game are not being ignored. They are being studied and will be the subject of special experimentation and, if necessary, of special localised measures fitted into our general scheme of control.

15. This scheme amounts to an attempt to destroy and control tsetse by means of agencies and resources already in existence and merely requiring to be diverted specially to that purpose and organised, and by enlisting the co-operation of the people themselves who are to be aided and protected. This is both the most practical way of dealing with the problem and the way that best accords with the sound policy of educating the natives to understand and attack their own problems and advance themselves through their own efforts.

Fig. 1. Destruction of grazing and starvation of cattle through overcrowding due to the advance of surrounding tsetse in the Usiha Sultanate of Shinyanga.

Fig. 2. Erosion due to destruction of grass in Usiha.

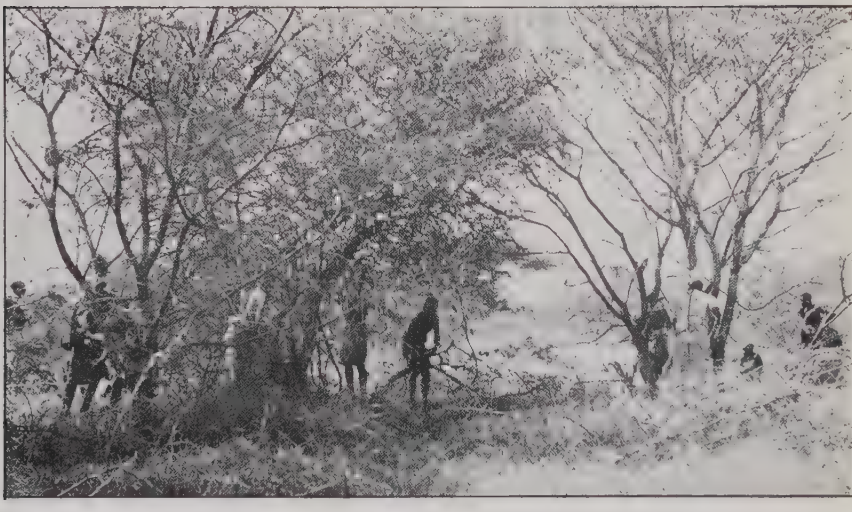


Fig. 1. Typical acacia bush of the type that is infested by *Glossina swynnertoni*. Clearers at work.

Fig. 2. Bush composed of *Strychnos*, *Pterocarpus* and *Combretum*, with thickets, haunted by *Glossina pallidipes* and *G. swynnertoni* in Nindo.

Fig. 1. Typical stream-side vegetation near Shinyanga; *G. swynnertoni* present.

Fig. 2. Typical natural "mbuga," or seasonal swamp, on the Manonga River; game abundant, but no fly.

Fig. 1. *Acacia spirocarpa* wooding at Kizumbi, still retaining much fly three weeks after felling.

Fig. 2. A planted hedge of "manyara" (*Euphorbia tirucalli*) in the felled wooding shown in fig. 1. Several living pupæ were found under it three weeks after the felling.

Fig. 1. Showing the effect of burning felled trees; after a late fire in the following dry season the branches and trunk would usually be consumed.

Fig. 2. A view of some of the clearing, showing the kind of ring-barking used to kill the larger trees of *Acacia spirocarpa*. Sultan Mwanasali seated.

Fig. 1. Typical "culture steppe" in the Shinyanga sub-district, showing dotted hedges, villages and cultivation. In foreground the schoolboys of a school built by Sultan Makwaia.

Fig. 2. Ploughing on the experimental block at Lubaga, from which tsetse bush has been cleared; infested bush in the background.

Fig. 1. A formidable breeding thicket at Kilosa in which cut dry grass was scattered before a grass-fire in October, 1921.

Fig. 2. The same, after the fire; the thicket has never reformed.

SKETCH MAP OF USUKUMA AND NORTH TABORA.

To illustrate the distribution of Types of Bush, Concentrated Population and Tsetse and the measures being undertaken for the control of the latter.

NEW CURCULIONIDAE ATTACKING TREES IN INDIA.

By Guy A. K. Marshall, C.M.G., D.Sc., F.R.S.

(Plate XVI.)

Subfamily Otiorrhynchinae.

Corigetus instabilis, sp. n. (Pl. xvi, fig. 1).

♂♀. Integument red-brown, clothed with dense scaling, which may be either nearly uniform grey, or nearly uniform sandy, or again either of these more or less heavily mottled with dark brown ; the pronotum with three very faint darker stripes.

Head with the forehead broad, about as wide as an eye, and not impressed, with the frontal fovea so shallow that it is hidden by the scaling ; the eyes nearly circular and almost flat. *Rostrum* broad, a little broader than long (5 : 4), with the sides almost straight and parallel or slightly divergent towards the apex ; the elevated median area narrowing very slightly from base to apex, broadly impressed, the impression being deepest between the antennae (where there is a short low median carina) and gradually becoming shallower behind ; the inter-antennal space two-thirds the width of the forehead ; the scrobes very broad and entirely dorsal, ending rather steeply behind (but without any transverse limiting carina) and rather longer than the space between the base of the scrobe and the eye ; the epistome very short and sloping very steeply, the posterior margin distinctly carinate and forming a median obtuse angle which does not extend backwards beyond a line drawn between the antennae ; the mentum with only two setae. *Antennae* rather stout, with the scape as long as the funicle and club together, only very slightly compressed, feebly curved, gradually widening from base to apex, densely squamose and with subrecumbent scale-like setae ; the funicle also squamose, the two basal joints equal, and the remainder all about as long as broad and of equal width ; the club rather short, ovate, as long as the three preceding joints. *Prothorax* somewhat broader than long, gently rounded at the sides, widest a little behind the middle, not constricted near the apex, much narrower in front than behind, and with the basal margin deeply bisinuate ; the postocular lobes almost obsolete and bearing a thin tuft of vibrissae ; the dorsum strongly convex transversely and quite flat longitudinally, set with irregular coarse subconfluent punctures, which are almost entirely concealed by the scaling, each puncture containing a short subrecumbent spatulate seta. *Scutellum* subquadrate, densely squamose. *Elytra* much wider at the shoulders than the base of the prothorax (16 : 11), gradually widening from the broadly rounded shoulders to behind the middle, and with a slight flattening on each side of the suture at the base ; the punctures in the shallow striae reduced by the scaling to a narrow slit containing a minute seta ; the broad intervals with small, subcircular, slightly overlapping scales, there being five or six across an interval on the disk, and with small, irregular, sparse, recumbent, scale-like setae. *Legs* with the femoral tooth very sharp and spine-like, and just beyond it a small projection bearing a tuft of a few setae ; the front tibiae not sinuate internally, the middle pair very slightly curved, and the hind pair with a sharp bare carina in the corbel, the upper angle of the latter projecting sharply.

Length, 4–4·8 mm. ; breadth, 1·75–2·1 mm.

Bombay : Kanara, 10♀♀, x. 1923 (*J. L. Bell*).

The adult weevils were found defoliating trees of *Casuarina equisetifolia*.

Distinguished from its congeners by its short, broad and parallel-sided rostrum, which with its general facies gives it a close resemblance to the genus *Platymycterus*, Mshl. (1918). In the latter, however, the rostrum is flat and tricarinate dorsally, the scrobes are abruptly delimited behind, the inter-antennal space is only half the width of the forehead or less, the epistome is not sharply carinate behind, the mentum bears six setae, and the corbels of the hind tibiae contain no internal carina.

Subfamily Magdalidinae.

Magdalis himalayana, sp. n. (Pl. xvi, fig. 2).

♀. Entirely black and rather shiny, except the scape of the antennae and the uncus of the tibiae, which are testaceous brown.

Head subconical, short, the distance from the hind margin of the eyes to the prothorax being much less than the length of an eye; the vertex shagreened and with separated shallow punctures; the forehead at its narrowest less than half the basal width of the rostrum, rugosely punctate, and set with curved whitish setae; the eyes not projecting, their curvature quite continuous with that of the head. *Rostrum* about as long as the pronotum, strongly curved, subcylindrical, very slightly widening from base to apex, smooth and shiny, and with rather sparse small punctures. *Antennae* with the scape strongly curved, slender, cylindrical and abruptly clavate; the funicle with joint 1 longer and much thicker than 2, 3 longer than broad, the remainder subglobular; the club much shorter than the funicle. *Prothorax* as long as broad, almost straight or very slightly rounded at the sides, gradually narrowing anteriorly and feebly constricted near the apex, the base deeply bisinuate; the dorsum strongly convex longitudinally, highest in the middle, closely set with rather shallow reticulate punctures, the intervals between which are shiny and not shagreened, with a smooth median line from near the base to two-thirds of the length, the anterior third with a feeble median longitudinal impression and a shallow impression in the middle of the base; the upper surface almost entirely bare, but with a few subrecumbent pale setae in the basal depression, and the pleurae with numerous setae. *Scutellum* elongate, bare, shiny, and sloping downwards towards the base. *Elytra* suboblong, gradually widening from the narrow and oblique shoulders to three-fourths the length, separately rounded at the base and there slightly overlapping the base of the prothorax, and with a broad shallow impression near the base; the striae deep and containing deep punctures, which become gradually shallower behind, and each of which bears a minute seta on its anterior edge; the intervals much broader than the striae, convex, shiny, shallowly and transversely rugulose, and with very minute irregular setae; interval 1 elevated near the scutellum. *Legs* rugosely punctate and with sparse pale setae; all the femora with a sharp tooth; the tarsal claws simple; the tibiae denticulate on the apical half of the inner edge.

Length, 3·3–4·8 mm.; breadth, 1·5–2·1mm.

United Provinces: Dharmoli, Kumaon, 1♀, vi. 1912; Kanasar, 5,500 ft., Chakrata, 5 ♀♀, iii. 1924 (*S. K. Pillai*).

This is the first species of *Magdalis* that has been recorded from India and belongs to the typical section of the genus, as defined by Reitter (Fauna Germ., Käfer, v, 1916, p. 123). Its nearest ally is *M. memnonia*, Gyl., which is a larger and rather more coarsely sculptured insect, having a longer head, the distance from the eye to the prothorax being as long as the eye; the pronotum lacks the smooth median line; the scutellum is much smaller; the basal angles of the elytra are slightly prominent; and the tibiae are not denticulate on the inner edge.

The specimens from Kanasar are recorded as having been bred from *Pinus longifolia*.

Subfamily CRYPTORRHYNCHINAE.

Camptorrhinus mangiferae, sp. n. (Pl. xvi, fig. 3).

♂♀. Integument black, with dense brown scaling; the pronotum with a broad median blackish-brown stripe and with a small infra-dorsal basal black patch, which extends on to the base of the elytra below the shoulder and on to the tip of the mesepimeron; the scutellum brown; the elytra with a large, common dorsal blackish-brown patch, sharply defined and angulate on its posterior edge (having there an indefinite pale edging), and ill-defined laterally, extending on the disk approximately to stria 5, but only reaching stria 3 on the basal fourth; a variable and irregular common blackish-brown patch on the declivity, and a rounded whitish spot on intervals 4 and 5 at one-third from the base (rarely obsolete); the lower surface paler, the three intermediate ventrites usually darker in the middle in ♀, and bearing two dark longitudinal stripes in ♂; the legs light brown, the middle femora with a large dark brown patch on the narrow shaft, the hind pair with almost the entire shaft dark; all the tibiae with a broad dark patch slightly below the middle.

Head very convex, densely covered with concave scales and with sparse squamiform setae, the scales on the vertex with their apices directed forwards, those on the forehead directed backwards; the forehead somewhat flattened and without any obvious fovea. *Rostrum* of ♂ closely and rugosely punctate throughout; of ♀, coarsely punctate at the base only, elsewhere with fine scattered punctures, the median line being impunctate. *Antennae* with joint 2 of the funicle much longer than 1, joints 3 and 4 longer than broad, together about as long as 1, 3 longer than 4, the remainder as long as broad or slightly longer. *Prothorax* a little longer than broad, strongly rounded at the sides in ♂, less so in ♀, narrowing rapidly towards the apex; the dorsal outline gently convex in ♂ (the apical area being slightly lower than the rest), and almost flat in ♀, in which the apical area is not depressed; the dorsum with its close punctation entirely hidden by the scaling, the scales obliquely implanted in the punctures and overlapping, with scattered recumbent incrassate black or brown setae, and usually with a trace of an abbreviated median ridge, which does not break through the scaling. *Scutellum* elevated, longer than broad and densely squamose. *Elytra* with the punctures in the striae partly obscured by the densely overlapping scales; the intervals without any tubercles or even granules, int. 1 obtusely elevated on the declivity and int. 3 from behind the middle to the apex, int. 5 terminating abruptly so as to form a marked posterior projection, and ints. 3 and 5 feebly raised and somewhat uneven in the basal half. *Legs* elongate; the apical half of the tibiae and the two basal joints of the tarsi clothed with dense long hairs on the two anterior pairs of legs of the ♂, the front tibiae having a slight angulation where the hairs commence, and the hind tibiae being long and slender, not strongly compressed or carinate dorsally, and only very shallowly bisinuate internally; in the ♀, all the tibiae slender and shallowly bisinuate internally. *Sternum*: the terminal portion of the prosternal furrow projecting backwards well beyond the hind margin of the prosternum, especially in the ♀, in which sex this portion is as long as the front coxae.

Length, 7·2–8·4 mm.; breadth, 2·4–2·9 mm.

BIHAR & ORISSA: Koina River, Singbhum, 1 ♂, 5 ♀♀, vi.-viii. 1921 (*C. F. C. Beeson*).

These insects were bred from mango trees (*Mangifera indica*).

The present species belongs to the group represented by *C. dorsalis*, Bdv., and *C. affinis*, Fst. (1895), and resembles these two species very closely in general form and coloration, but the male can at once be distinguished by the fact that the median legs are clothed with long hairs on the tibiae and tarsi just like those of the front pair, and the rostrum is much more rugosely punctate and has no smooth

median line or carina ; the female differs, *inter alia*, in having the post-coxal portion of the sternal furrow produced well beyond the base of the prosternum, in having no sharp angulation on the inner edge of the hind tibiae, and in the apical joints of the funicle being at least as long as broad and not transverse. *C. dorsalis* differs from the other two species in its more coarsely punctate elytra, its much broader tibiae, and in having the two basal joints of the funicle subequal.

Subfamily Zygopinae.

Phylaitis pterospermi, sp. n. (Pl. xvi, fig. 5).

♂♀. Integument black ; the head beneath the eyes and a small basal patch at the side of the rostrum covered with pinkish scales ; the prothorax with the middle of the disk apparently almost bare, but actually clothed thinly with narrow recumbent blackish-brown scales and with a very indefinite narrow cross formed of sparse narrow white scales, the adjoining lateral areas (corresponding roughly to the space between striae 4 and 6 on the elytra) with similar scattered dark brown and white scales, an elongate patch in the middle of the base formed of much broader, densely overlapping, forwardly directed white scales, and the pleurae and lower surface densely clothed with light pinkish scales variegated with brownish pink ; the scutellum with dense white scales ; the elytra with larger brown scales (principally in the punctures) having a bronze or coppery reflection, and variegated with numerous smaller white scales, the margins of the suture bearing a dense row of obliquely transverse white scales only ; the sternum densely covered with large white scales, but the lateral sternites of the mesosternum and the basal half of the sides of the metasternum with blackish brown scales and a few white ones scattered among them ; the venter also with white scales, the two basal ventrites with indefinite brown markings towards the sides.

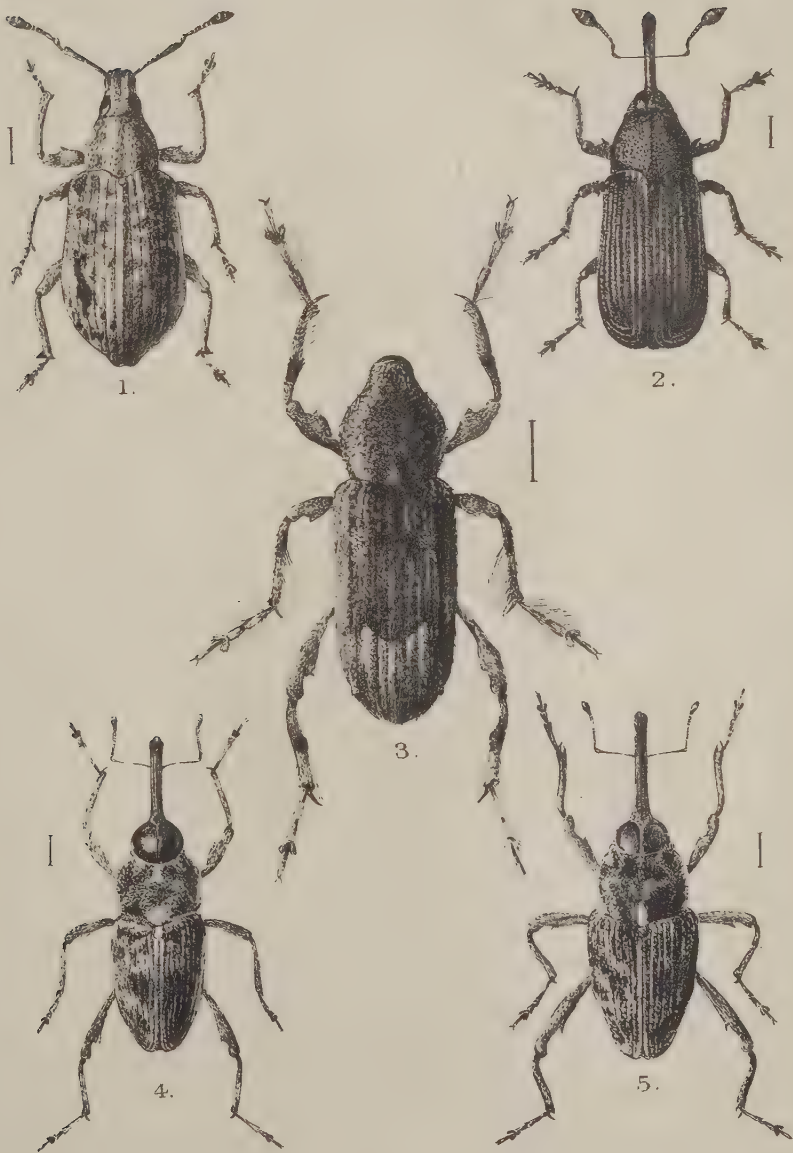
Rostrum closely punctate, with five carinae in the basal portion, the median carina continued beyond the antennae in ♂ but not in ♀ ; the dorsum thinly clothed at the base with small narrow transverse white scales. *Antennae* testaceous, with the two basal joints of the funicle subequal. *Prothorax* somewhat broader than long (6 : 5), almost straight at the sides and very slightly widening anteriorly to near the apex, and there rapidly narrowed and constricted, the basal angles rounded ; the dorsum highest near the base and sloping forwards, with rather deep and closely reticulate punctures throughout, each puncture containing a narrow scale. *Scutellum* round and somewhat elevated. *Elytra* widest at the shoulders and rapidly narrowing behind, with a shallow transverse impression at the base and the basal half of the sutural area depressed, the apical margin finely denticulate ; each puncture in the deep striae covered by a broad scale ; the intervals finely rugulose and subgranulate, without spines in ♂, and ints. 3 and 5 not more raised than the others. *Legs* with mottled brown and white scaling and rugulosely punctate ; all the femora with a narrow low carina on the outer and inner face (but these more distinct in the hind pair than in the others), and with a small longitudinal lobe in front of the tooth in both sexes ; the front tibiae and tarsi of ♂ clothed with long hairs. *Sternum* with the usual prosternal spines of the ♂ well developed, upwardly curved and sharply pointed, and the hollow between them partly filled up with dense erect scales ; the space between the front coxae about as wide as the funicle of the antennae. *Venter* : the first visible ventrite of ♂ without a deep depression, and the last ventrite flat and squamose throughout.

Length, 4-5 mm. ; breadth, 1·8-2·4 mm.

United Provinces : Golatappar, Dehra Dun, 3 ♂♂, 7 ♀♀, iv. 1923 (*N. C. Chatterjee*).

EXPLANATION OF PLATE XVI.

Fig. 1. *Corigetus instabilis*, sp. n., ♀.
,, 2. *Magdalis himalayana*, sp. n., ♀.
,, 3. *Camptorrhinus mangiferae*, sp. n., ♂.
,, 4. *Phylaitis pterospermi*, sp. n., ♂.
,, 5. ,, *scutellaris*, sp. n., ♂.



New Indian Curculionidae.

The insects were all bred from the wood of *Pterospermum acerifolium*.

From the previously described Oriental species *P. pterospermi* may be distinguished by the pinkish colouring of the prosternum, the elongate patch of dense white scales at the base of the pronotum, and the presence of the small lobe in front of the femoral tooth on all the legs. *P. v-alba*, Pasc., from Malaya, which comes nearest to it, has, in addition to its very different colouring, a transverse apical impression on the pronotum; no basal or sutural depression on the elytra, but interval 1 distinctly elevated and finely denticulate behind the middle; no carinae or lobes on the femora; the prosternal spines straight and obliquely truncate at the apex, and the cavity between them very deep and without erect scales; the front coxae subcontiguous, etc.

Phylaitis scutellaris, sp. n. (Pl. xvi, fig. 4).

♂♀. Integument black or piceous, the legs and often the rostrum red-brown; the head with dense buff scaling below the eyes; the pronotum with dull orange or dark pink scales, extending laterally to the level of the side margin of the elytra, and marked dorsally with the following, often indefinite, dark patches (apparently bare, but really set with bronze-black scales): a rounded one in the middle of the disk, two broad oblique ones just in front of it and almost touching the front margin, and a broad lateral stripe on each side; the scutellum with dense white scaling; the elytra with rather thin dull orange or golden brown scaling, with very indefinite and irregular dark patches, notably, a large one behind the middle extending from the suture to stria 4 and another round the posterior callus; interval 1 with dense white scaling for a short distance behind the scutellum, thence to the middle a few large white scales scattered on intervals 1-3 and some similar scales on the posterior declivity, the sutural edge having a row of small fringed white scales, and the basal margin with an edging of erect white scales; the prosternum with dense large buff or yellowish scales; the rest of the lower surface with dense large white scales, except for an irregular blackish-brown patch on the anterior half of the metepisterna (the white scales on the posterior half having sometimes a pinkish tinge).

Rostrum with close shallow confluent punctation throughout and with five rather indistinct fine carinae in the basal section; the area between the lower lateral carina and the scrobe with rather dense, pale buff scaling. *Antennae* testaceous brown, with the two basal joints of the funicle subequal. *Prothorax* broader than long (5 : 4), gently rounded at the sides, rapidly narrowed at the apex and there shallowly constricted, but the constriction not extending across the disk, the basal angles rounded; the dorsal outline only slightly convex, highest behind the middle; the dorsum throughout with closely reticulate punctures, each containing a scale; the dorsal scales for the most part oblong, the dull orange scales below the dark lateral stripe being broader and more ovate, but much smaller than the white scales on the prosternum. *Scutellum* larger than usual, broadly ovate, and with densely overlapping white scales. *Elytra* ovate, the sides being subparallel from the shoulders to beyond the middle, then narrowed to the apex, the margin of which is not denticulate; no transverse impression at the base, and the basal half of the suture not depressed; the striae rather broad and deep, containing large punctures, each of which is covered by a scale; the intervals rather narrow, rugulose and finely granulate; int. 1 narrowly carinate from before the middle to near the apex and set with very small, backwardly directed denticles; int. 3 still more elevated for a short distance at about the middle and there bearing four or five much larger denticles. *Legs* black or piceous, not very densely clothed with narrow whitish scales and rugulosely punctate; the femora without lateral carinae and without lobes in front of the femoral tooth; the front tibiae and tarsi of ♂ without conspicuously long hairs. *Sternum* of ♂ with the prosternal spines acute at the apex and slightly curved upwards, the hollow between them very deep and circular; the space between the

front coxae about as wide as the antennal club. *Venter* of ♂ broadly and deeply excavate at the base; the last visible ventrite squamose throughout and with a shallow median groove.

Length 4–4·5 mm., breadth 1·6–1·8 mm.

UNITED PROVINCES: Riverain Forest, Nagsidh, Dehra Dun, 1 ♂, bred from *Eugenia jambolana*, vi. 1924 (*C. F. C. Beeson*—type); Lachiwala Range, Dehra Dun, 1 ♀, bred from *Acacia pennata*, iv. 1921. BOMBAY: Nasik, 1 ♀, bred from *Cassia auriculata*, vi. 1918.

This species is more nearly related structurally than the preceding one to *P. v-alba*, Pasc., although the colouring is quite different; the structure of the femora is the same, but the scales on them are distinctly broader and densely cover the tooth on the hind pair, whereas in *v-alba* this tooth is devoid of scaling, and bears a fringe of setae along its posterior edge. *P. scutellaris* further differs, *inter alia*, from these two species in its much larger scutellum, which is twice as broad, and in the denticulate ridge on interval 3 of the elytra. The latter character occurs also in *P. lauta*, Hllr. (1893), from Perak, but that species has a similar ridge on int. 5, joint 2 of the funicle longer than 1, and a very different colour pattern.

A NEW *ARMIGERES* (DIPTERA, CULICIDAE) FROM CERAM (MOLUCCAS).

By S. L. Brug,
Centraal Militair Geneeskundig Laboratorium, Weltevreden, Java.

Armigeres denbesteni, sp. n.

Male and *female.* Head mainly clothed with black flat scales, with a narrow white border to the eyes broadening laterally, sometimes a central white patch; some upright forked black scales behind. Proboscis black, as long as the front femora in the female, a little shorter in the male. Palpi black; exceeding the proboscis by the length of the apical segment in the male, not quite a quarter as long as the proboscis in the female. Antennae dark brown, pale-banded in the male; the border of the cup of the torus thickly clothed with small flat white scales, especially on the inner side.

Mesonotum with brownish black scales and a narrow white margin. Scutellum flat-scaled, mid lobe white medially, dark brown laterally, side lobes dark brown. Sometimes there are on the mesonotum just before the scutellum some white scales, narrow curved ones anteriorly, flat ones posteriorly. In other specimens the whole of the scutellum and antescutellar space are dark-scaled. Prothoracic lobes with white scales on the anterior and the superior surface, anteriorly broader, and small black curved scales on the posterior surface. Proepimera with white scales, curved on the upper part, flat on the lower part. Pleurae black with patches of white flat scales; lower part of mesepimeron with one bristle.

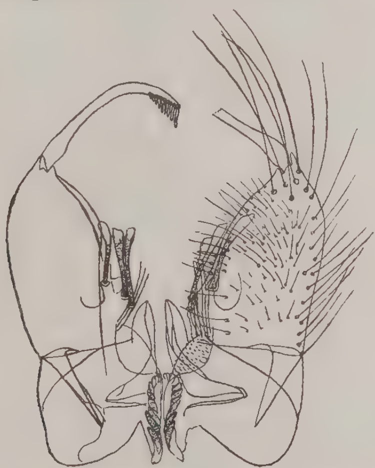


Fig. 1. Male genitalia of *Armigeres denbesteni*, sp. n.

Legs dark, except the inner side of the femora, which is partly, and the outer side of the hind femora, which is wholly, white. Claws: in the male: fore leg unequal, untoothed; mid leg equal, both with one small tooth; hind leg equal and simple; in the female: fore leg straight, equal, one-toothed; mid and hind leg equal and simple.

Wings dark-scaled. Base of first fork-cell nearer the apex of the wing than that of the second. Fork-cells nearly $1\frac{1}{2}$ times as long as the stems in the male, not quite twice as long in the female.

Abdomen: Tergites i-vii dorsally black with triangular basal lateral white patches, extending almost to the apices of the segments; viii basally white, apically black or wholly white. Sternites i and ii wholly white, sometimes iii also; iii (iv)–vi mostly white, with a narrow apical black border, v and vi with a narrow black basal border also; vii black with a narrow white subapical band, viii basally white, apically black (male) or wholly black (female). External male genitalia: vide fig. 1.

Larva. The conspecificity of the larva and the imagines described here could not be proved with absolute certainty, as the breeding of single larvae and mounting of the larval skin was not practised. However, there can hardly exist any doubt as to it; Dr. den Besten sent me a great number of larvae, which proved to be *Armigeres* larvae, and a good collection of imagines, all belonging to one species of *Armigeres*, and bred from larvae from the same breeding place.

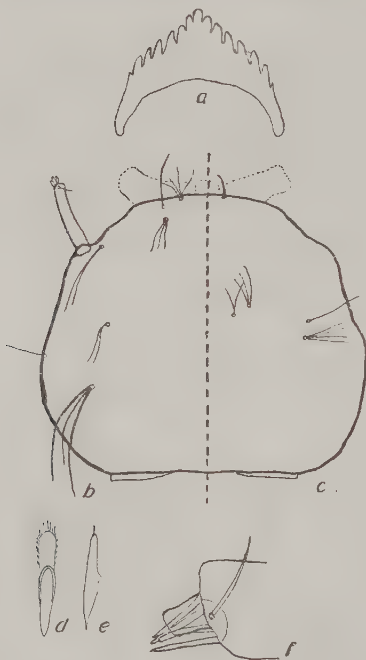


Fig. 2. Larva of *Armigeres denbesteni*, sp. n.: *a*, mental plate; *b*, dorsal cephalic hairs; *c*, ventral cephalic hairs; *d*, scale on 8th segment, front view; *e*, same, lateral view; *f*, tip of antenna.

Cephalic hairs (fig. 2, *b*, *c*): Inner clypeal hair 4- or 5- (rarely 3-) branched, outer clypeal hair simple, hind clypeal hair 2-, 3- or 4-branched. One anterior occipital 1-, 2- or 3-branched hair; one strong posterior occipital 2- or 3-branched hair, directed backward. Near the base of the antenna is a 2- or 3-branched hair. Ventrally there are two mental hairs on each side, each with 2 or 3 branches. Two genal hairs, the foremost simple or 2-branched, the hindmost with 3, 4 or 5 (rarely 1 or 2) branches.

Antennae short, cylindrical, slightly curved, nude except the tip (fig. 2, *f*), which is provided with four obtuse bristles, one projecting plate and a minute hair directed backward and inward.

Mental plate (fig. 2, *a*) somewhat broader than long, with some 13 teeth, the mid ones obtuse, the outer ones a little sharper.

Scales on the eighth segment : 7-11 on each side, obtuse, with fairly conspicuous fringe at the apex (fig. 2, *d*, *e*).

Siphonal tube : twice as long as broad, without pecten, with one small 2- or 3-branched hair inserted on the border line between the apical and the subapical fourth parts of the tube's length.

Habitat. This mosquito was found breeding in the ditches carrying the refuse water of the sago preparation in various villages in the West of the Island of Ceram (Moluccas) by Dr. den Besten. I have much pleasure in dedicating it to its discoverer.

Type ♂, paratypes 1 ♂ 2 ♀, and 3 larvae presented to the British Museum.

A NEW BLOOD-SUCKING MIDGE FROM SINGAPORE.

By J. W. S. Macfie.

Genus **Haemophoructus**, gen. nov.

♀. Eyes bare. Proboscis long, the stylets strongly chitinised for blood-sucking. Antennae with scanty, short hairs; the last five segments elongated. Without thoracic pits. Wings with both microtrichia and (a few) macrotrichia; a single radial cell; and the fourth vein petiolate. Legs with femora and fifth tarsal segments unarmed; tarsal segments sub-cylindrical. Claws small, equal. Empodium well developed. Spermathecae two. Male not known.

Haemophoructus maculipennis, sp. n.

Length of body* (four females), 2·3 mm. to 2·8 mm.; length of wing, 1·8 mm. to 1·9 mm.; greatest breadth of wing, 0·67 mm. A rather dark brown midge with spotted wings almost devoid of macrotrichia, a single radial cell, and well developed empodia.

Head dark brown. Eyes bare, except at the extreme periphery where there are a few minute, erect setae, broadly contiguous above, the facets separated only by a narrow line. Clypeus brown, bearing four hairs. Proboscis long, the stylets strongly chitinised, and resembling in form those of *Culicoides*; mandibles armed distally with about 19 teeth set in a compact row, maxillae with about 23 teeth in a somewhat looser and longer row. Palpi brown, about as long as the proboscis. First segment very small; second long and sub-cylindrical (about 25 units by 6 units†); third slightly longer than the second (about 32 units), somewhat dilated in the middle, furnished with a small sensory pit, and bearing also numerous sensory hairs on the surface of the segment; fourth segment shorter (about 12 units) than the fifth (about 19 units), the latter segment not dilated at its end.

Antennae almost uniformly darkish brown, but the torus rather darker than the flagellum segments. First segment rather large, bearing a few (seven) short hairs. Torus sub-spherical, rather small, bearing a few (six) short hairs. Third segment a little larger than the fourth, oval, about 20 units by 11 units, with a very short stalk and bearing two long spines, five hairs (about the same length as the segments), and several small sensory pits. Segments 4 to 10 oval or slightly flask-shaped, sub-equal, from 16 by 9 to 17 by 7 units, each bearing a whorl of four rather short hairs (about the same length as the segments) on the basal half, a pair of long, brownish, slightly curved spines, which are stouter than the hairs, longer than the segments (about 25 units), and taper to sharp points, a smaller almost straight spine, and (usually) one or two small sensory pits. Segments 11 to 15 elongated, sub-cylindrical, their basal breadths about uniform (6 units), and their lengths progressively increasing, in one specimen measuring 31, 32, 34, 36, and 53 units respectively; the segments bear numerous short hairs and small spines, and the last segment tapers distally, but does not end in a stylet. The combined length of segments 11 to 15 (186 units) greater than that of segments 4 to 10 (122 units), or segments 3 to 10 (142 units).

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* This measurement is taken from the anterior margin of the thorax to the tip of the abdomen of specimens mounted in pure carbolic acid.

† The unit referred to is 3·7μ.

Thorax dark brown ; adornment, if any, indistinguishable in the specimens examined which had been preserved in alcohol. There are no thoracic pits, and the hairs on the dorsum are scanty. Pleurae dark brown. Scutellum dark brown, shaped as in *Culicoides*, bearing two lateral and two centro-marginal bristles, but no small hairs. Post-scutellum dark brown, with a small depression posteriorly.

Wings brownish, especially near the anterior border, with numerous pale spots arranged as shown in the diagram (fig. 1, *a*). Wing surface densely clothed with rather large microtrichia, and bearing also a few macrotrichia near the tip of the wing above the fourth vein, between the rami of the fourth vein, and just below the lower ramus of the same vein. Hairs on the costa and anterior veins stout and bristle-like. Fringe (not shown in the diagram) short, on the posterior margin of the wing composed of alternating long and short hairs. Costa reaching beyond the middle of the wing (75 : 102) and slightly arched anteriorly near its end. There is only a single radial cell, of which the proximal part is much narrower than the distal part. The petiole of the fourth vein about as long as the cross-vein. Halteres with brown knobs.

Fig. 1. *Haemophoructus maculipennis*, gen. et sp.n., ♀ : *a*, wing ; *b*, claw and empodium *c*, spermatheca.

Legs almost uniformly darkish brown, the terminal tarsal segments, however, a little paler than the rest of the legs ; well clothed with short hairs. Femora not expanded, unarmed. Hind tibiae slightly expanded at the apex, and bearing a stout spur and two transverse rows of bristles, the proximal row composed of numerous small bristles, and the distal row of six large, graded bristles. Tarsal segments cylindrical, progressively diminishing in length, but the fifth a little longer than the fourth and unarmed. First tarsal segment longer than the second on all the legs, about two and a-half times as long on the fore legs, nearly three times on the middle legs, and rather more than twice on the hind legs. Claws equal, simple, nearly half the length of the last tarsal segment. Empodium about as long as the claws, delicate, hairy (fig. 1, *b*).

Abdomen darkish brown, sparsely hairy. Cerci somewhat paler brown than the rest of the abdomen. Spermathecae two (fig. 1, *c*), highly chitinised, pyriform, and slightly unequal, in one specimen measuring in total length and greatest breadth 74μ by 55μ, and 59μ by 44μ respectively.

MALAYA : Singapore, 1924, 4 ♀♀ (*Commander D. H. C. Given*).

These insects were described as blood-suckers by the collector, and in two of them the abdomen was distended with a hard, dark mass resembling blood. The mass was removed from one specimen and proved in fact to be mammalian blood, the red corpuscles of which were similar to those of human blood.

Culicoides inornatipennis, C. I. & M.

MALAYA: Singapore, 1924, 1 ♀ (*Commander D. H. C. Given*).

The single female collected resembles very closely the African species *C. inornatipennis*, but the two spermathecae are oval or pyriform, slightly drawn out at the base, and measure in total length about 66μ, and in greatest breadth about 48μ. *C. inornatipennis* is a variable species, and as at present there is available for comparison only a single female of the Singapore species, there does not appear to be any reason for regarding the African and Malayan species as distinct, although to determine the synonymy satisfactorily further specimens, especially males, from the latter locality will have to be examined.

THE SEASONAL PREVALENCE OF FLEAS IN EGYPT.

By C. B. Williams, M.A.,
Acting Chief Entomologist, Ministry of Agriculture, Egypt.

Visitors to Egypt during the spring tourist season frequently complain of the great abundance of fleas in this country. These insects are at this period a source of endless annoyance to all save those few fortunate individuals who, for some unknown reason, have no attraction for them.

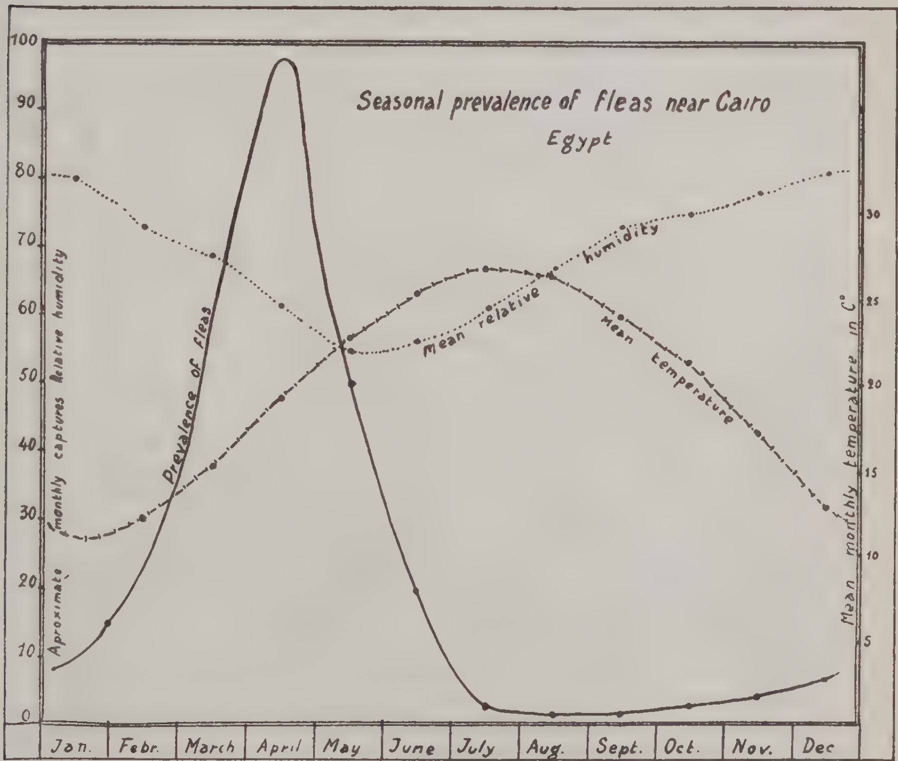

Fig. 1.

When one resides during a longer period it soon becomes evident that this great abundance of fleas is not a permanent feature, but has a definitely seasonal variation, and just as there are times when life is almost a burden owing to their attentions, there are months when none are to be seen or felt.

During a residence of over three years in the vicinity of Cairo I have noted down at frequent intervals the approximate intensity of the flea nuisance, and the results appear to be worth putting on record, as I am not aware that this has yet been done.

The normal course of events in my experience is as follows: During August and September it is an exceptional event to be bitten by a flea; during October one or two are to be met with; during November and December they are a little more frequent, but still rare—say four or five during the month. Towards the end of January they begin to increase rapidly, and from one every day or two in February, they reach one or two every day in March, and at the end of March and in April seldom a day passes without my catching three or four adults, and sometimes as many as ten. During May they decrease rapidly—with the exception noted below. In June life becomes bearable again, and in July they are once more rare, perhaps three or four during the whole month.

I have examined specimens at intervals at all times of the year, and they have been, without exception, *Pulex irritans*.

These changes are shown graphically in figure 1. They vary slightly from year to year, and the cycle described is an average. In 1922 the maximum appeared to be in March and not in April. What little evidence we have indicates that in Upper Egypt the maximum occurs earlier than in the Cairo district.

It should also be recollected that while the times of maximum and minimum attack are probably the same for all people, the actual numbers will vary greatly according to the sensitiveness of the individual.

The temperature (Centigrade) and humidity conditions in the Cairo district are as follows:—

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
Temperature:												
Mean Max....	19·1	20·9	23·9	28·1	31·7	34·2	35·1	34·3	31·5	29·5	25·2	20·6
Mean ...	10·9	12·3	15·2	19·0	22·6	25·4	26·6	26·3	23·9	21·6	17·3	12·7
Mean Min....	5·5	6·3	8·3	11·5	14·4	17·5	19·4	19·8	17·7	15·7	11·9	7·7
Humidity:												
Mean ...	80%	73	69	61	55	56	61	67	73	75	78	81

Both mean temperature and mean humidity are shown in fig. 1. The former has its maximum in July and its minimum in January; the humidity is at its maximum in December and its minimum in May.

It will be seen that the fall in the number of fleas occurs on the advent of the hot weather (maximum over 30° C., mean over 22·5° C.), but while there is a slight increase with the fall of temperature in the autumn, the really great increase does not occur until after the cold weather in January, and when it is once more becoming warmer. The maximum in the spring occurs with a mean temperature of 15–19° C., but there is no maximum in the autumn at about the same mean temperature in November. The humidity in November is, however, much higher than in April, and it is possible that this has an influence.

The maximum attack is therefore at the cool dry time of the year, but whether this is significant or not can only be determined by comparison with other localities. The relation is shown in figure 2, where the annual cycle of changes of combined mean temperature and mean humidity is given as a closed curve, and the maximum and minimum flea periods indicated on opposite sides of it. The numbers on the curve are the months of the year at which the particular combinations occur.

It is, of course, recognised that the temperature and humidity conditions under which the fleas lie do not exactly correspond to the air shade conditions, but until their exact breeding grounds are known and studied we have no more significant figures to consider.

As is to be expected with a phenomenon that forces itself on the notice of the ordinary individual, there are a number of popular explanations of the abundance of fleas in the spring, some of which have almost entered the ranks of superstition. Thus one hears in many parts of Egypt that the fleas come from the bean fields, merely because the maximum infestation occurs at the same time as the bean harvest.

Another general belief is that the fleas are blown from the desert. Now, while it may be taken for granted that the source of the infestation will be found in the thickly populated villages and not in the desert, there appears to be some evidence for a connection between their abundance and high winds. The most striking case of this that has come under my observation was in May 1924. For a week the average catch had fallen to one or two a day, after a very bad April. On the evenings of the 12th and 13th there were heavy "Khamsin" winds laden with dust, and on

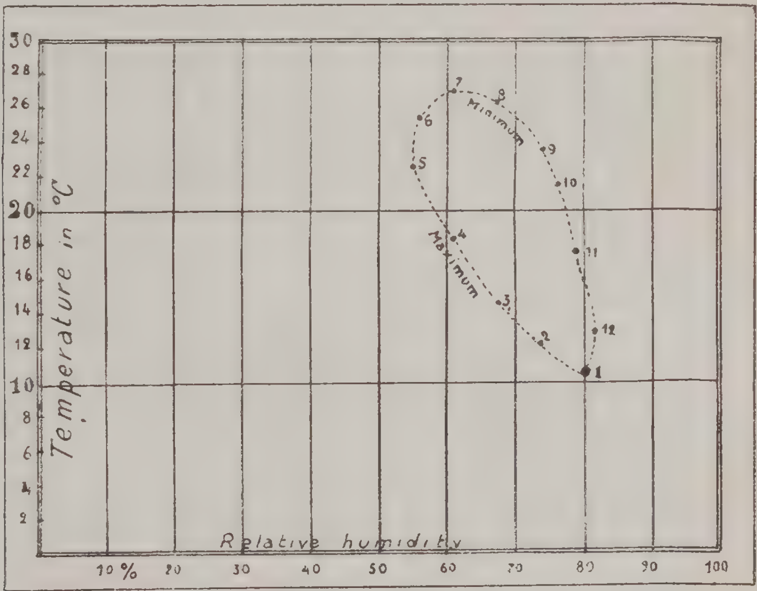

Fig. 2.

the morning after the first storm my wife and I caught nineteen fleas while dressing, and for nearly a week the captures averaged about a dozen a day. Other people, including another entomologist, confirmed the sudden recrudescence of attack following the two heavy winds. It is, of course, possible that we are dealing only with a coincidence, but, in view of the general belief on the subject, exact details are interesting for comparison with future observations here or elsewhere.

Cairo, 15th December 1924.

MOSQUITOS UNDER WINTER CONDITIONS.

By Malcolm E. MacGregor,

Wellcome Field Laboratory, Wisley, Surrey.
(Wellcome Bureau of Scientific Research.)

It is too often assumed that mosquitos in cold climates always adopt one of two methods of passing the winter: Either (1) that with the decline in the atmospheric temperatures in the autumn the adults cease their reproductive functions, and develop a "fat-body" on which they nourish themselves during the winter months while they rest in a semi-dormant condition in situations sheltered from fatally low temperatures; or (2) that with the decline in atmospheric temperatures during the autumn the adults of a particular species die off, and that their larvae, by adopting a semi-dormant state, are able to keep alive in their habitats, even though the water may freeze and enclose them in a block of ice.

It has become the custom to think of mosquitos of cold climates either as species which "over-winter" as larvae or as adults, but this is far from true in all cases.

Adults and larvae of many species exhibit both these methods of passing through the adverse winter conditions, but it is not generally realised how many species simultaneously adopt both methods—the larvae living throughout the winter in their normal breeding-places, while the adults hide in sheltered situations.

As I write (1st January 1925) there are the following species of larvae in my laboratory which have been collected in large numbers within the last two days from ponds, marshes, and tree-holes whose waters are either frozen or have been at freezing-point for the past week, and which have been at low temperatures for the last three months: *Aëdes* (*O.*) *rusticus*, *A.* (*O.*) *vexans*, *A.* (*O.*) *nemorosus*, *A.* (*F.*) *geniculata*, *Anopheles plumbeus*, *A. bifurcatus*, *Theobaldia annulata*, and *Culicella morsitans*.

Of these species adults of *Anopheles plumbeus*, *Aëdes* (*O.*) *rusticus*, *A.* (*O.*) *nemorosus*, and *A.* (*F.*) *geniculata* have been obtained from hollows in trees and from a wood-man's hut, while adults of *Theobaldia annulata* and *Culicella morsitans* have been collected in considerable numbers from local stables and pig-styes.

It is certainly true, so far as our present knowledge is concerned, that some species apparently pass the winter months solely either as adults or as larvae, as, for instance, in the case of *Culex pipiens*, the adults of which may be obtained commonly in sheltered situations throughout the winter, while the larvae seem to disappear completely during the winter months; and *Anopheles bifurcatus*, the larvae of which are easily found in small streams throughout the winter, while the adults, so far as I know, have not been encountered passing the winter in that state.

It is, however, not safe to assume that even such species are bound to follow one or other method of survival during the winter, and under favourable conditions it is likely that both larvae and adults of the species would maintain their existence.

Mosquitos cannot be classed as animals which enter a state of true hibernation. It is well known that the adults of many species continue to feed at intervals during the winter, and observations upon the larvae over several winters in England have shown that the insects continue feeding and developing even though the water is only a few degrees above the freezing point. If the larvae belong to a species which can survive these temperatures, feeding and development cease temporarily when the water actually solidifies, but when the ice melts the insects' metabolism and growth are resumed.

The effect of low temperatures is simply to inhibit the development and activities of both the larvae and adults, in most cases, but not in all, inhibiting also the functions of the reproductive organs until the atmospheric temperatures rise again. In a recent paper* Wright substantiates this statement by a reference to his capture of a female *Theobaldia annulata* containing mature ova in the month of January.

In climates where the winter temperature falls far below the summer temperature, but does not actually reach the freezing point, curves indicating the speed of metabolism, development and reproduction follow almost exactly the rises and declines in temperatures—when other influencing factors are discounted.

In the past many proposals have been put forward for the destruction of the overwintering adults with a view to inflicting heavy slaughter and a severe check to the future multiplication of the particular species. In some localities where it can be definitely established that the species exists in that locality during the winter only as the adult such measures are practicable, but careful and prolonged search for the larvae, even if they are apparently absent, must previously be undertaken if the measures are not to be fruitless.

Under winter and other adverse conditions mosquito larvae have a remarkable aptitude for avoiding danger. They will apparently disappear from ponds and streams where they have been formerly numerous when adverse conditions occur, but the larvae may in reality still be there.

For example, there is a small stream not far from this laboratory which has its source in a lake. Larvae of *Anopheles bifurcatus* for some reason have never been found in the lake itself, but 50 yards from the source of the issuing stream large numbers of larvae are to be found among the vegetation at the banks in the winter months. When the recent floods in England were at their height the width of this stream, from being normally a few feet, increased to a width of many yards, and the stream became a small torrent. Search all along the edge of the abnormal stream resulted in no larvae being discovered, although specimens were at the time urgently required for laboratory investigations. A week later, when the floods had subsided and the stream was back to nearly its normal level, a search for larvae was again undertaken. Large numbers were easily obtained from exactly the same situations along the banks for which they had exhibited previously a marked preference. There can be little doubt that these larvae had not been replaced by others, since prolonged search at all seasons in the lake had failed to reveal larvae there, and it therefore seems certain that the larvae were able to adopt some means of retaining their position in spite of the flood. The same thing is true in the case of mosquitos breeding in ponds, marshes and tree-holes. In spite of much flooding, now that the water levels have fallen nearly to normal there seems to be no noticeable decrease in the numbers of the larvae at any of the different situations.

That the number of larvae in a particular area during the winter is considerably less than during the summer is unquestionable, but the existence of the larvae of many species throughout the winter has to some extent been overlooked.

Factors which contribute to the difficulty of finding larvae in winter arise from the effect low temperatures have upon the metabolism and growth of the larvae. For instance, if larvae in a pond or elsewhere are frightened they dive in the normal manner, but whereas in summer within a few minutes most will be at the surface again, in winter, owing to the comparative torpidity they exhibit, and the much decreased rate of respiration, they may, and generally do, remain submerged for long periods. Thus the searcher's "dippers" possibly remain empty, and his conclusions are likely to be incorrect unless account is taken of this fact.

* W. Rees Wright, "On the Hibernation of Adult Mosquitoes."—*Anns. of Trop. Med. & Para.* xvii, no. 4, 30th Dec. 1924.

NOTE ON THE WHEAT BULB FLY (*LEPTOHYLEMYIA COARCTATA*, FALL.).

By H. M. Morris, M.Sc.,
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This insect has been known for many years as the cause of serious loss to the wheat crops in this country and on the Continent, having been first recognised in 1882, although it probably occurred before that year. In some seasons the damage occasioned by this fly is so severe as to cause the almost complete destruction of the crop in some fields, although more often it results in the crop being made thin and patchy. The damage first becomes apparent in March and April, when the leading shoot of the young plants attacked turns yellow and the plant if small or weak dies off. The injury is caused by the older larva, which feeds within the young shoot. This destruction of the young plants usually occurs in patches about the field, and the bare patches so caused increase in size owing to the larvae moving in the soil from plant to plant, each larva being thus able to destroy several plants. In addition to winter wheat this pest can attack winter barley and winter rye, although such attacks are rare in this country. It can also attack couch grass. Neither oats nor any other crop is attacked. In Great Britain the most severe damage due to this insect has generally occurred in the eastern counties of England and Scotland, although serious injury has also occurred in various other districts, and the severity of the attack has varied enormously from season to season. Damage due to this pest has also been reported from Middle and South Russia, Germany, Austria, Holland, Sweden, Norway, Denmark, France, Tunisia and Mesopotamia.

The most complete accounts of the life-history of *Leptohylemyia coarctata* are those given by Petherbridge (1921) and Gemmill (1923). There has been considerable uncertainty as to the stage of development in which the winter is passed, and it was formerly believed that this fly was double-brooded in this country, the larva of the second brood being thought to occur in couch and other wild grasses. Now, however, it is recognised that there is only a single brood, although in warmer countries it is probable that a second generation may occur. The life-history is briefly as follows :—

The adult flies appear in July and lay their eggs during the latter part of that month and on into the early autumn. The eggs are laid in soil which, for the time being, is bare or largely bare, such as occurs in a field being fallowed or land in which potatoes or other root crops are growing. Most of these eggs hatch about the following February, and the newly-hatched larvae enter wheat plants if such are available, and continue feeding until about May, when the then fully-grown larvae pupate, the adults emerging in July. The wheat bulb fly is remarkable among phytophagous insects in that it lays eggs in the bare soil in the absence of its host-plant. The first definite evidence indicating that this procedure actually takes place was afforded by Petherbridge, who observed that the eggs were laid in the bare soil in breeding cages. Two years later Gemmill recorded the first observations of finding them in the field. He remarks that the places chosen for laying the eggs are practically always bare loose soil surfaces. During a recent examination of samples of soil from a field at Rothamsted on which mangolds have been grown annually for many years, a number of eggs of this fly have been found, and confirmation is thus afforded of the observations just alluded to. The samples were each a 9 inch cube of soil, and between 30th October 1923 and 9th January 1924, 30 eggs were found, giving a distribution of approximately 166,000 per acre. In addition, a number were

found which appeared to have already hatched, although no larvae were found either in the soil or in the occasional plants of couch grass which occurred in the samples. The soil was sifted by means of the washing apparatus previously described (Morris, 1922), the eggs being found in the final residue. The eggs occurred chiefly in the surface inch of the soil, but six were between a depth of one and three inches, and one between three and five inches. The eggs (fig. 1.) are creamy-white and shining;

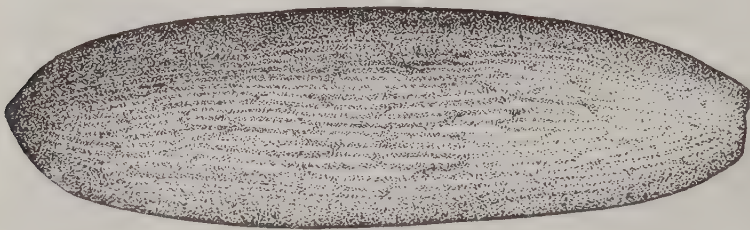

Fig. 1. Egg of *Leptohylemia coarctata*, Fall. ×80.

cylindrical in shape and slightly curved, and taper at both ends. The posterior end tapers to a point, while at the other extremity the chorion is thickened in the form of a ring, the centre of which is slightly depressed and is thinner than the remainder of the chorion. The eggs are about 1·3 mm. in length and 0·4 mm. in breadth. Under a microscope they show longitudinal ridges which fork and fuse to a limited extent. They develop slowly; a few larvae emerge the same autumn, but the greater number do not hatch until about the following February. Kept in the laboratory on damp blotting paper, a number of eggs hatched between 19th December 1923 and 14th January 1924. In hatching, the larva emerges from the egg by a V-shaped slit near the anterior end.

The newly emerged larvae were placed on young wheat plants growing in pots, and adult flies were obtained between 2nd and 11th June, 1924, the plants having been kept in an unheated greenhouse. Several of the wheat plants were destroyed, and larvae were observed in plants other than the ones on which they had been placed, thus indicating their capacity for migrating.

During the previous season wheat had been grown in an adjacent field, and, although no damage had been noticed attributable to this fly, it appears probable that there had been a certain amount of infestation by the bulb fly, and some of the adult flies produced had travelled to the mangold field to oviposit.

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THE SEASONAL HABIT OF THE COMMON ANOPHELINES OF NYASALAND,

WITH A NOTE ON ITS RELATION TO THE SEASONAL INCIDENCE OF MALARIA.

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It is an early experience of the Field Entomologist in the Tropics, whether his work lies in countries such as the East African Protectorates, which have well defined seasons, or where the seasons are less clearly marked, as in the Federated Malay States, that a seasonal prevalence of the commoner insects is quite as definite as it is in the Temperate regions. Outside the Tropics the main factor determining prevalence would seem to be suitability of temperature, but in the Tropics, where temperature variations may be slight, moisture is the controlling factor. Purely terrestrial insects which feed, whether as larvae or imagos wholly on vegetable material, breed and are most abundant at such times as the food-plants are at their best, that is when, as the result of favourable conditions of temperature and moisture, there is a full flow of tissue-building sap. The law of seasonal prevalence is valid also for many insects whose imagos derive their food directly from the larger animals, a source of supply available at all seasons. For these insects, too, the same conditions hold good, but affect chiefly the larvae.

Many smaller insects which are aquatic during the larval stage show in the Tropics a seasonal prevalence quite as definite as those that are wholly terrestrial, though the factors that determine their prevalence appear to be quite unknown. Chironomid flies, for instance, are at certain seasons wafted over Lake Nyasa in clouds so dense as to simulate the smoke of a passing steamer ; and EPHEMERIDAE may appear in such numbers as even to obscure lamplight. There is strong presumptive evidence that mosquitos are affected by seasonal prevalence, although precise information bearing on this phenomenon, both for mosquitos and for all insects directly affecting man, is largely lacking.

In the following paper it is proposed to give mainly some account of an enquiry carried out for the purpose of discovering to what degree the more purely domestic mosquitos of Nyasaland conform to seasonal influences.

The pressing need for such an investigation, and its more immediate objects, are well defined in the following paragraphs extracted by kind permission from a letter written by Dr. G. A. K. Marshall commenting on a similar investigation (the results of which are as yet unpublished) carried out by the writer in the Federated Malay States during 1920 :—

> " If any really satisfactory attempt is to be made to control or exterminate mosquitos by means that will not involve such excessive outlays as large drainage schemes, it is essential that we should have the fullest knowledge of the intimate life-history and habits of the more important malaria-carrying mosquitos . . . .
>
> " Our knowledge of the seasonal behaviour of tropical mosquitos is extremely deficient ; and yet if an organised attack was to be made on any given species, this would be one of the first points upon which information would be required . . .
>
> " Again, in cases where there is a periodic seasonal diminution in the numbers of an Anopheline, a concerted attempt to destroy early broods would certainly yield beneficial results later in the season ; although in actual practice anti-mosquito measures are usually deferred until the insects have become abundant, and an effective reduction of their numbers is then much less feasible."

The present enquiry was commenced in March 1922, and continued until March 1924, at Fort Johnston, in 14°27'S, 35°15'E, a township at an elevation of about 1,560 ft., about six miles south of Lake Nyasa, having a population of about twenty Europeans but large numbers of natives in the immediate neighbourhood. The district is particularly favourable for mosquito study because of the immense body of permanent water, in the Shire River, here deep, about 100 yards broad and largely covered in the dry season, when the river is stagnant, with floating aquatic plants, especially *Pistia*. Either bank is almost wholly fringed with papyrus and other reeds and is swampy at intervals whatever the season.

During the early rains a slight current northwards towards the Lake is set up by the influx of water from mountain streams to the south, the outflow of the river into the Zambesi being of late years obstructed; in the later rains there is a reflux in the opposite direction from the overflow of the Lake.

The river and its immediate neighbourhood form the main permanent breeding place available for mosquitos; but during the rains large numbers of temporary breeding places are formed by the accumulation of water in natural and artificial hollows in the ground, most of which very soon dry up at the change of season. The seasons in Nyasaland fall sharply into dry and wet; the rains usually begin in late November or December and continue to March, after which there is a drought lasting until towards the end of the year, but broken by an occasional thunderstorm.

For the purposes of this enquiry, systematic collections of mosquitos together with examinations of known breeding-places were made at regular intervals. From March 1922 to March 1923 all captures were carried out three times a week on alternate days, in the native hospital, a building divided into three small wards, and situated about thirty yards from the river. The building was peculiarly favourable for making captures; it was whitewashed internally, and was well lit by two windows to each end ward, four to the centre ward, and by three doors, all at one side. The writer aimed at clearing it as completely as possible of mosquitos at each collection; and in order to ensure that this was done provision was made for the collectors to reach the tops of the walls, and they were kept at work until it was found (from personal examination) that no mosquitos remained. In the course of the year 11,829 mosquitos were collected and identified. Of these 10,418 (68 per cent.) were Anophelines, chiefly *Anopheles costalis*, Loew, and *A. funestus*, Giles. The remainder consisted of *A. mauritianus*, Grp. (13 in all) and of 1,411 *Taeniorhynchus* (*Mansonioides*), with occasional *Stegomyia* and *Culex* species.

In the following table (A) is shown the actual number of the Anophelines taken in each month, together with the monthly rainfall figures.

TABLE A.

	1922. Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	1923. Jan.	Feb.
Rainfall in ins.	2·58	2·07	—	0·19	—	—	0·71	0·70	3·72	7·95	4·27	9·25
A. costalis females ...	*45*	10	19	8	8	25	24	12	7	*33*	*254*	*480*
A. funestus females ...	181	97	258	472	770	1,094	1,374	596	608	951	849	808

The conclusions inherent in this table are clearly (1) the overwhelming abundance of *A. funestus* throughout the year; (2) the comparative rarity of *A. costalis* during the dry months, and (3) the marked increase in the numbers of *A. costalis* which took place when the rains were well forward. The rainy season was far advanced when, in March 1922, collecting was begun, and it is clear from the figures obtained at the end of the year when the seasonal rains set in that the increase was again in direct proportion to rainfall.

The systematic collections of the second year were made in the native gaol, a building little larger than the hospital, about 130 yards from the Shire and at the back of a number of other buildings. This also was cleared of mosquitos in the same way as the hospital building, and a total of 20,689, of which 14,706 were Anophelines (71 per cent.), was obtained. The following table (B) shows month by month the actual number of the two Anophelines taken :—

TABLE B.

	1923. Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	1924. Jan.	Feb.
Rainfall in ins.	5·16	1·35	0·61	—	—	0·74	—	0·63	0·61	4·54	1·72	5·49
A. costalis females ...	*462*	*130*	113	187	72	23	7	10	5	2	68	*274*
A. funestus females ...	571	309	365	761	744	785	818	2,007	1,664	1,057	1,500	1,921

The numbers obtained were considerably larger than in the previous year, possibly because the place selected was nearer breeding grounds or because the heavier rainfall during the second year made conditions more favourable for breeding.

The figures for 1923–4 show, and still more conclusively, the enormous increase in the numbers of *A. costalis* that takes place when the rains are well advanced, and the corresponding rarity of this species in the drier months, and further, as previously noted, the dominance of *A. funestus* throughout the year. It might be added that the systematic collections from the gaol were continued throughout March 1924, when the rainfall was 6·78 in. ; 717 females *A. costalis* as against 1,465 *A. funestus* were taken.

Still further confirmation of the seasonal incidence of *A. costalis* is afforded by the data of captures made from time to time in another locality—a native hut distant about two miles from the Fort and from the river. These captures were made primarily for a purpose other than the study immediately under discussion and took place at irregular intervals. Less significance, therefore, is to be attached to the actual numbers taken than to the relative proportion of the two Anophelines during the round of the seasons. These data are as follows :—

TABLE C.

	1923. April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1924. Jan.	Feb.	Mar.
Monthly rainfall ...	1·35	0·61	—	—	0·74	—	0·63	0·61	4·54	1·72	5·49	6·78
A. costalis females ...	26	98	23	11	3	—	—	3	15	57	*147*	*172*
A. funestus females ...	13	230	462	256	13	48	134	336	215	240	482	164

Indirect confirmation of the dry season scarcity of *A. costalis*, so markedly noticeable in the foregoing tables, is afforded in a paper by Dr. C. W. Daniels, published so long ago as 1900.[1] Dr. Daniels lays stress on the importance of *A. funestus* as being " the most numerous, the most widely distributed, and the most persistent frequenter of houses," and goes on to state that " the other anopheles are of more limited distribution, but some of them are found at places far apart. Of these the *Anopheles costalis* is of the most importance, as it seems to be the chief agent on the West Coast of Africa. This anopheles is found on the Zambesi and Lower Shire Rivers, and in the northern part of Lake Nyasa, but I have failed to find it in the Shire Highlands and the Upper Shire rivers . . . In some places this mosquito may be of importance, but as regards the interior it can only be of minor importance as compared with *Anopheles funestus*."

There can be little doubt that the failure of so acute and experienced an observer as Dr. Daniels to find *costalis* in the Shire Highlands and in the Upper Shire valley is due to his having visited the district in a dry season. This is certainly the reason

why Professor Newstead and Dr. Davey, who collected along the valley of the Upper Shire in 1911 during the dry season from July to the beginning of November, failed to find among hundreds of Anophelines, mostly *A. funestus*, more than a single example of *A. costalis*. In their paper[2] they record of *A. funestus* that: "This malaria-carrying mosquito was the most abundant of all the Anophelines observed by us.

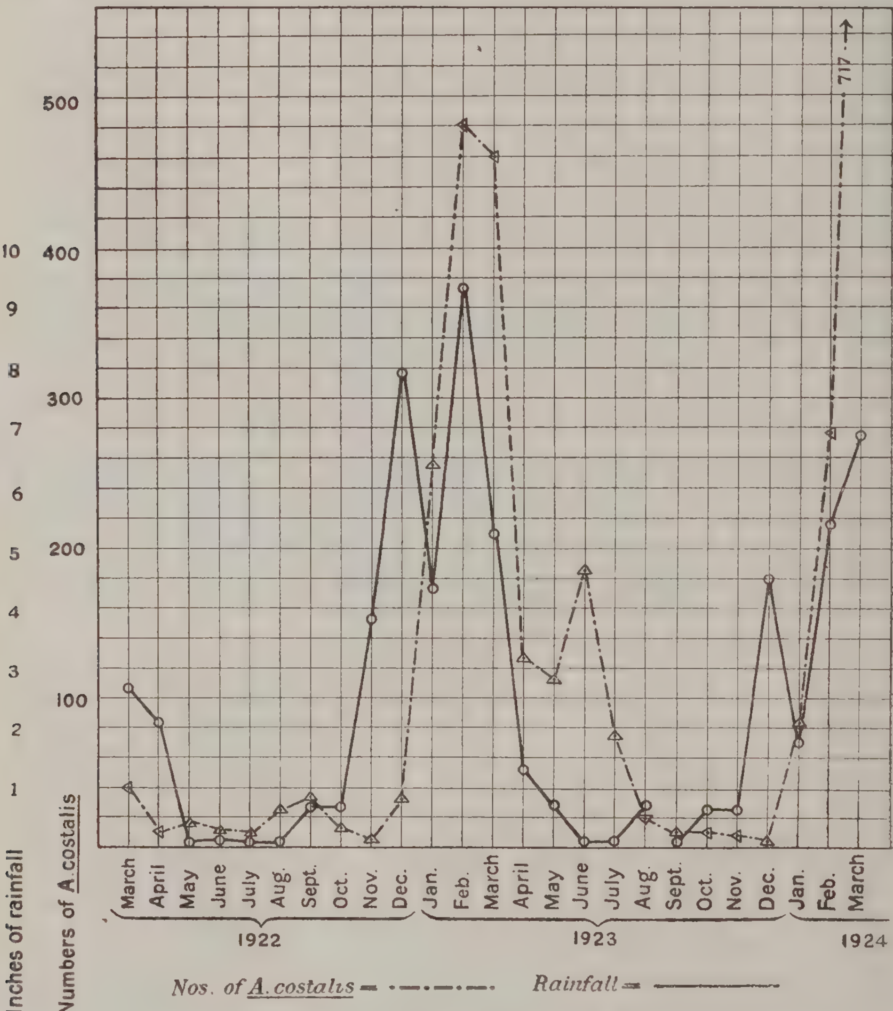

Fig. 1. Graph showing the correlation between rainfall and the numbers of *Anopheles costalis*, Lw.

On 31st July we decided to fix our permanent camp on the banks of the Shire, opposite Matuta's village, but our tents became so badly infested with this mosquito that we decided to abandon the site, selecting a more open spot a short distance away. Our first camping ground in this locality was surrounded by tall and, for the most part, densely foliaged trees, and was distant from the river about 80 yards. The permanent

site of the camp was 200 yards from the water in practically open country. We found, however, that this Anopheline was equally abundant in both places: on August 2nd one hundred and eleven specimens of this species were counted in one of the tents, and there were certainly an equal number present in the other tent. The temperature on this occasion at 3 a.m. was 48°F., at midday 86°F. in the shade, and at 8·30 p.m. 55°F. On 9th August, one hundred and sixty-two specimens of this species were captured in one of the tents."

Having these results in mind, the writer visited in the wet season of 1924, in April, the neighbourhood in which Professor Newstead and Dr. Davey had collected. *A. costalis*, though not so numerous as *A. funestus*, was readily obtained in the tent on two successive mornings early; at Nkata's 47 *funestus* and 10 *costalis*—at Chimesia's 6 *costalis*.

Further evidence of the existence in the wet season of *A. costalis* still further south along the valley of the Upper Shire at Liwonde was obtained from the examination of a small collection of mosquitos most kindly supplied by Major S. J. Pegler, D.S.O. Out of a total of thirty Anophelines taken by him on the 24th and 25th of April 1923, twenty were *A. funestus*, the remainder *A. costalis*.

Some evidence of a wet season prevalence of *A. costalis* elsewhere in East Africa (in Zanzibar) is brought forward in the annual report of the Economic Biologist of that Protectorate for 1922. It is stated (page 65) that *Anopheles costalis* is the only species recorded from the "town area," and the relative numbers of this mosquito taken by collections made once a week throughout the year in three different localities are given, together with the rainfall. The data may be tabulated as follows :—

	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
Rainfall ...	0·37	1·62	0·59	0·32	5·39	9·41	1·78	0·00	0·00	3·31	2·10	13·00
A. costalis												
Central goal	37	7	3	0	0	5	31	3	2	3	18	19
Native Hospital	4	0	0	0	0	4	0	0	0	0	0	0
European ,,	1	0	0	0	0	0	0	0	0	0	0	0

The data from a town such as Zanzibar, with thoroughly efficient sanitation even in the native quarter, are necessarily meagre; they do, however, lend some support to the conclusions reached at Fort Johnston.

Data for the Northern Provinces, Nigeria, made available in 1919 by W. B. Johnson[3] show that there also the seasonal prevalence of *A. costalis* is quite a definite phenomenon. The table afforded shows that during rains sufficiently heavy in July 1917 (as he points out) to wash away larvae there was no increase of *costalis*. During the steady rains of August there was a marked increase of this Anopheline, males in particular; during September data were not obtained (the writer of that report being away), but during October at the end of the rains there was a still greater increase in the numbers of the insect taken. In November, when a dry cold N.E. wind started, there was a sudden and very considerable fall, and this was maintained until June 1918, when at the end of the rains an increase of *A. costalis* again took place. The numbers of *A. funestus* obtained were relatively quite small, this species forming 16·6 per cent. of the total Anopheline catch, as against 81·1 per cent. of *A. costalis*, but more were obtained during October and early November 1917 than during any other month.

Seasonal Breeding Habits of *A. costalis*.

During 1923, and along with the study of the seasonal prevalence of the mature insects, a periodic examination of the breeding places of *A. costalis* was made in order to discover the breeding season (if any) and to secure information as to larval behaviour during the dry season.

A. costalis is essentially a small-pool breeder, favouring for oviposition small collections of rainwater in natural hollows of the ground, in borrow-pits, depressions

at the sides of the road, in animal hoof-prints, and very occasionally in artificial breeding places such as old earthenware pots. A dearth of such breeding places may account in part, but by no means entirely, for the lessened numbers of the Anopheline during the dry season.

Among the breeding places of Fort Johnston were certain pits which had been dug here and there to supply water in the dry season to the gardens along either bank of the Shire. These gardens are usually at about fifty yards from the river and well away from the fringe of tall reeds which make approach to the river difficult. There is water in these pits at all seasons, largely derived from the river, and rising and falling with it according to the season ; but during the wet season there are, of course, considerable accessions of rain water. The pits are usually about three feet in diameter, and may have a depth of nine inches to a couple of feet in the dry season. In the wet season most of them are surrounded by grass, which either withers in the dry weather and is burnt, or is cut off short by termites. At all seasons the pits lie open to sun. At the end of the rains in late March 1922, and again in 1923, the larvae of *A. costalis* occupied these pits in myriads. By late May 1923, they were relatively scarce. In one pit, one hundred and fifty-six only, associated with the larvae of *Lutzia* and *Calex univittatus*, were collected after much hard work—a number which could have been obtained in a few minutes a few weeks earlier. In June and early July larvae could still be obtained, but much more sparingly, and by the 1st August in the mid dry season they ceased to exist, at least so far as could be ascertained. In one pit, however, Anopheline larvae, still associated with larvae of *C. univittatus*, were obtained on 1st August, but they were found to be those of *A. mauritianus*, a species which had certainly never been taken there before. A month later, and thereafter until the rains broke, the only larvae taken from this and the other pits were *C. univittatus*, and these, latterly, in greatly diminished numbers. But within a week of the first rainfall, which fell on 7th December, the larvae of *A. costalis* were again found sparingly in the pits, round the margin of which grass had already sprung up ; and in water which had collected in a test-pit newly dug in the centre of a plot of ground free from vegetation there were soon considerably more than in other pits, a point of very considerable interest. At the end of three weeks they became so numerous as actually to create a little ripple on the surface as they scurried off to the opposite side on one's approach. In all the pits the water had changed in the meantime from the colour of weak tea (caused by the presence of decomposing vegetable matter) to a bright green, due to the enormous numbers of chlorophyll-containing organisms held in it.

It would seem therefore that the immature forms of *A. costalis* occur in the Shire valley only in the wet season ; and further, that this seasonal occurrence accounts for the great rise in the number of imagos which takes place at that time.

Important corroborative evidence as to breeding season was obtained from male captures of the species, and will be found set out in the following tables, D and E.

TABLE D.

	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Monthly rainfall ...	2·58	2·07	—	0·19	—	—	0·71	0·70	3·72	7·95	4·27	9·25
A. costalis ...	5	5	1	—	—	—	—	—	—	—	2	8
A. funestus ...	45	2	15	20	43	277	445	310	69	94	43	38

TABLE E.

Male collections 1923–24 (*a*) in goal, and (*b*) in native hut.

	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Monthly rainfall ...	5·16	1·25	0·61	—	—	0·74	—	0·63	0·61	4·54	1·72	5·49
(*a*) *A. costalis*	41	3	3	—	—	1	—	1	—	—	—	—
(*a*) *A. funestus*	45	3	6	5	8	26	43	199	133	99	79	60
(*b*) *A. costalis*	—	9	19	2	—	—	—	—	—	2	—	12
(*b*) *A. funestus*	—	8	61	69	70	21	19	77	168	15	117	61

It might be added that during March 1924, with a rainfall of 6·78 inches, 20 male *costalis* were taken as against 43 of *funestus* in the gaol, and 56 *costalis* as against 65 *funestus* in the hut. This evidence therefore confirms the facts already adduced as to breeding season; a relative abundance of males coincided with the increase of females.

Possible Explanation of Seasonal Prevalence.

The absence of larvae in permanent breeding-places in the dry season might be explained on the assumption either that the females do not oviposit or that the ova laid at that time do not hatch until the season is more favourable. But the few females then taken had invariably fully distended ovaries, and readily oviposited under artificial conditions in the laboratory. Moreover, all the ova hatched in due course, though in a few instances only was it possible to devote the care necessary to ensure the larvae reaching maturity. A female captured on 17th August 1923 (mid dry season) laid about 87 ova on 19th, and these duly hatched two days later. A female taken weeks later, on 4th September, laid on 6th about 141 ova, all of which hatched. Another female taken on 1st October laid 110 ova which hatched on 14th; and another taken on 12th November laid ova from which were reared between 24th and 27th December two males and three females. A female taken on 16th November laid ova on the 18th from which were bred up between 28th of that month and 1st December five male and four female offspring; and a female taken on 28th November, immediately before the rains, oviposited a day later, eighteen male and seventeen female offspring emerging between 9th and 12th December. No selection of the female Anophelines was made for the experiments; they were indeed so rare at the season as to make any choice out of the question, and one had to be content to use such as came along.

It will be seen that this experimental evidence seems to be in direct conflict with the results obtained from field work. But the behaviour of an insect in captivity must of necessity be greatly modified by the artificial conditions in which it finds itself. For instance, a captured Anopheline will oviposit in the laboratory on waters in which its larvae are not known to occur in nature. The Oriental *A. maculatus*, a breeder in clear moving water, will lay its eggs in still water whether from rain butt or cesspit. *A. funestus*, a river breeder (at Fort Johnston at all events) will oviposit on water from small pools such as in nature contain the larvae of *A. costalis* only. Moreover, the larvae of many species will certainly feed up and reach maturity on algae quite distinct from those with which in nature free larvae are associated. A familiar example of such adaptation to unusual conditions occurs in the case of some Lepidopterous larvae, particularly those of moths, which, if supplied from the egg with food material on which they do not occur in nature, will feed up and reach maturity, though if once fed upon their proper food-plant they will thereafter refuse any other. It is within the writer's experience that Chalcids which normally attack the puparia of blowflies will in captivity breed on the puparia of *Glossina*; and various parasites—Mutillids and Chalcids naturally peculiar so far as is known to *Glossina*—can be bred successfully in captivity on the puparia of blowflies, "green-bottles" and fruit-flies. Many other similar examples might be afforded. The behaviour of an insect in captivity is not, therefore, necessarily a sure guide to its conduct under natural conditions. Despite the laboratory results it seems probable that the absence of natural larvae in the dry season may be due to the inhibition of the ovipositing instinct in the Anopheline at times such as are unfavourable both to its mature and immature offspring. In insects the act of oviposition appears to be a reaction to suitable external stimuli; contrasting with the act of parturition in vertebrates, which takes place in obedience to a rhythmical and inherent impulse wholly independent of external surroundings. What, then, are the conditions that determine oviposition in mosquitos? In the temperate zone an essential appears to

be mere rise of temperature to a suitable degree, but in many parts of the Tropics this can hardly be the determining factor. At Fort Johnston the mean minimum temperature during the cooler months of the year—June to August—may certainly fall as much as fifteen degrees lower than it does towards the end of the year, when *A. costalis* begins to appear in numbers ; but even then it is very rarely lower than about 56°F. This daily fall in temperature is more often than not very transitory, and lasts a few hours only, a minimum being reached before dawn, whereas Anopheline activity is at its maximum shortly after dusk, when presumably oviposition takes place. Moreover, there can hardly be a variation so great as materially to affect the larvae in the temperature of the water of *costalis* breeding places, which at Fort Johnston are situated in sandy heat-retaining soil.

The following table gives the shade temperatures at Fort Johnston during the period in which the collections of imagos were made, together with data relating to the prevalence of female *A. costalis*.

	1922. Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	1923. Jan.	Feb.
Mean Max. Temp. F. ...	90·64	90·13	88·12	82 83	82·77	86·51	89·33	92·2	96·1	86·5	88·74	84·82
Mean Min. Temp. F. ...	—	—	—	56·33	56·93	61·22	64·3	69·1	72·1	69·51	70·87	69·96
A. costalis ...	45	10	19	8	8	23	24	12	7	33	*254*	*480*

	1923. Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	1924. Jan.	Feb.
Mean Max. ... Temp. F. ...	87·00	82·45	81·16	81·50	82·33	83·76	89·7	93·12	97·53	87 03	89·1	84·14
Mean Min. Temp. F. ...	69·68	66·00	62·32	55·00	—	—	—	—	—	—	—	—
(*a*) *A. costalis*	462	130	113	187	72	23	7	10	5	268	274	—
(*b*) *A. costalis*	—	26	98	23	11	3	—	—	3	1,557	147	—

The probability is suggested that the seasonal occurrence of *A. costalis* may ultimately be found to depend less absolutely on temperature than on a change in a complex of conditions—composition of water, algal content, etc.—which the subtle instinct of the Anopheline is quick to detect and to profit by, and which indeed guides the choice of the insect in the final selection of a suitable breeding place. If temperature alone is accountable it is difficult to understand how, of two species having the same range, so far as this has been determined, one only should be affected.

Seasonal Prevalence of *A. funestus*.

There would hardly seem to be any definite optimum season for *funestus* at Fort Johnston, judging by the capture data already cited, which show that the female imagos occurred in great adundance throughout the whole year. It is perhaps suggestive, however, that in both systematic collections the males show a relative abundance in the late dry season—in August to October of 1922, and in October and November of 1923, as will be seen from the following data :—

Male collections of A. funestus, 1922–23.

	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Monthly rainfall ...	2·58	2·07	—	0·19	—	—	0·71	0·70	3·72	7·95	4·27	9·2
A. funestus ...	45	2	15	20	43	*277*	*445*	*310*	69	94	43	38

Male collections, 1923–24.

	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Monthly rainfall ...	5·16	1·35	0·61	—	—	0·74	—	0·63	0·61	4 54	1·72	5·49
Gaol coll. ...	45	3	6	5	8	26	43	*199*	*133*	99	79	60
Hut coll.	—	8	61	69	70	2	19	77	*168*	15	117	61

It would be well nigh impossible to obtain by the systematic collection of larvae any information at Fort Johnston as to the breeding season for this species. The area of water available in the Shire River is so great that a considerable amount of work is necessary even to secure a few. The larvae, moreover, take cover among the tall aquatic plants fringing the water, where it is extremely difficult to get at them. The question requires study in another locality.

Anopheline Prevalence in relation to Malaria.

It now remains to consider the seasonal incidence of *A. costalis* in relation to the seasonal occurrence of malaria. Reliable data as to the part played by this Anopheline—and this might be said of all species of Anophelines in E. Africa—appear to be strikingly meagre. If, however, *costalis* is as efficient a carrier on the East Coast as it has been shown to be on the West, it is to be anticipated that its seasonal increase, occurring in the late rains, would be accompanied by a marked increase in the malaria rate. So far as can be ascertained, no attempt has yet been made in the East African Protectorates to correlate the prevalence of the disease with Anopheline activity, but reports dealing with the health conditions are unanimous in emphasising, again and again, the marked increase in the number of the cases that does take place in the wet season. In the Annual Medical Report for Nyasaland, 1909–10, it is stated (page 2) in reference to Malarial Fever that " taking the remittent type of malaria, under which the bulk of cases are returned, the figures indicate fairly definitely a seasonal incidence." Thus, in the cool dry months of the year, and about six weeks after the cessation of the rains, there were in June 33 cases, July 25, August 23 ; in the warm dry months September 48, October 53 ; from November to March, corresponding to the wet season, 65, 58, 37, 37, 38 and 58 cases respectively ; in April, when the rains are ceasing, 100 cases ; in May, when the marshes are commencing to dry up, 114 cases. In a later report, that for 1912 (page 3), it is stated that " the seasonal incidence of malaria has corresponded with that of previous years, the largest proportion of cases having occurred during and shortly after the wet season. It should be remembered, however, that not a few Europeans get infected while travelling, and this circumstance needs to be borne in mind when considering the seasonal distribution of cases among this community." In the report for 1913 it is stated that the most malarial months were January, February and May, " the seasonal incidence of malaria being, as usual, most marked at the height of and shortly after the rainy season."

For precise data as to the seasonal incidence of malaria in various localities in Nyasaland the writer is indebted to his colleague Dr. W. Milne Tough, who most kindly undertook the laborious work of compiling them from the hospital records during a period of twelve years—from 1911 to 1923. The data from five localities show without exception a very considerable rise in the malaria rate during the rains and a diminution during the drier months. The figures from Fort Johnston are as follows :—

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
169	*125*	75	78	44	51	67	44	63	74	*142*	*144*

During the late wet season of 1923–24 the general rise in the malaria rate throughout the country was indeed so definite as to call for comment in the popular press.

In the annual medical report for the Uganda Protectorate for 1912 it is stated (page 9) of malaria that " seasonal influence is marked in this disease, as will be seen by the accompanying composite chart for the whole Protectorate, and it is almost invariably found that the admission rate increases or decreases in proportion to the amount of rainfall, the greatest incidence being usually at the end of the rainy season." In the report from the same Protectorate for 1913 it is stated as regards malaria (page 12) that " seasonal influence continues to be marked, as will be seen by the

accompanying composite chart for the whole Protectorate, in which a definite relation is shown to the rainfall," and further, in the report for 1914 (page 11), that "seasonal influence was again marked and an increased malarial incidence was probably due to an unusually heavy and continued rainfall." In the report from the Nairobi laboratory, July to December 1911, Dr. P. H. Ross states (page 2) : "I find that there are two distinct malarial seasons, one after the big rains of April-June, and another following the small rains of October-November. The number of cases of malaria diagnosed in the laboratory is much greater for the big rains than for the small rain period." Actual data showing the incidence of malaria month by month in relation to rainfall and confirming these observations are given in the reports from the same laboratory for 1913 and 1914, and in the report from the same laboratory for 1915 (page 57) the "usual increase of malaria following some weeks after heavy rain" is referred to. In the report for 1919 (page 11) the following paragraph occurs: "As previously noted in the Annual Reports from this Laboratory, there was a large increase in the number of cases of malaria following the long rains in March and April. Usually there is another increase following the short rains; but as these rains were very light in 1919, there was no apparent effect on the malaria curve." The phenomenon is quite a definite and regular occurrence in Kenya therefore. In the report for 1921 of the Dar-es-Salaam Laboratory, Tanganyika Territory, it is stated (page 192) that "there was a curious rise in the malarial incidence which continued well after the maximum rainfall. There was a marked rise in the rainfall in April and May, and again in October and November, and yet the maximum incidence of malaria did not occur until May and June in the one case, and January in the second case, which month shows a very small rainfall. A period thus occurs of at least five weeks after the maximum rain precipitation and before the malarial incidence is at its height."

Special interest attaches to the data brought forward by Sir Ronald Ross in Mauritius[4], for at the time of his visit (1908) the only Anophelines found were *A. costalis*, *Myzorhynchus mauritianus*, which, as he states, "apparently does not carry malaria," and *Nyssorhynchus maculipalpis*, Giles, which was not common and found in three localities only. *A. costalis* was then the *principal*, if not the only, carrier of malaria in Mauritius. Ross states of the climate that it is "that of tropical islands, warm, equable and humid. The cooler season lasts from May to October, the warmer from November to April . . . Rain falls at all seasons, but there are two rainfall maxima, one in February and one in August, and two minima, one in June and one in September. In speaking of the monthly variation in the deaths, he states that "as a general rule, in malarious countries the admissions for malaria and the total number of deaths tend to increase largely in the rainy season, but in non-malarious countries this variation does not occur with regularity . . . Dr. Meldrum gave statistics to show that the greatest mortality tends to occur about two months after the heaviest rainfall. This is now easily explained by the impetus given to the breeding of mosquitos by the rains. A few weeks later many new infections would be produced by them, causing or accelerating deaths a few weeks later still." Further on he gives figures for the average monthly fever deaths in Mauritius during two sets of years, expressing the opinion that the sources of error regarding returns are likely to be less than in any other tropical country he has seen, including India. The following are these figures :—

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
1870–89 ...	393	537	578	629	673	601	518	430	369	358	335	351
1904–6 ...	377	428	662	673	666	565	328	305	369	350	321	338

He remarks that "they agree very closely and show a distinct seasonal variation. The fever mortality is least in November and greatest in the autumn months, as usual."

In a preliminary report on an enquiry into the Causation of Blackwater Fever in Southern Rhodesia[5], Dr. J. G. Thomson states that *A. costalis* is by far the most

important and most numerous of the Anophelines, and is apparently the chief carrier of malaria; his statements as to the monthly incidence of malaria have, therefore, especial interest in relation to the subject under discussion. He remarks that "the cases of malaria commence with the first rains at the onset of summer in October, and steadily increase during November, December, January, February and March, finally reaching a maximum in April. The first and last three months of every year supply the rainfall and ideal temperature required for the rapid multiplication of anopheline mosquitos. A chart in this report shows clearly that as the incidence of malaria rises the cases of blackwater increase, and as the malaria falls there is a corresponding diminution of blackwater." "The worst months for blackwater fever are April, May and June, as it is during these months the full effects of malaria occur, and the sudden drop in the incidence of blackwater during the months of July, August and September corresponds in a remarkable manner to the diminution of malaria and the disappearance of mosquitos."

It is suggested that an interpretation of the seasonal incidence of malaria on the West Coast of Africa, which is emphasised again and again equally as on the East Coast in the annual reports of the Medical Departments, may be found in the seasonal prevalence of *A. costalis*, as to which the data brought forward by Dr. W. B. Johnson for Northern Nigeria has already been referred to. Other evidence bearing directly on the matter is afforded for the Gambia in a report of the Malaria Expedition by Dr. J. Everett Dutton,[6] who stated that "the commonest mosquitos met with in Bathurst were *Stegomyia fasciata* and *A. costalis*. While in Bathurst I never saw specimens of *A. funestus*." He then goes on to remark that "the rainy season is fully established by July and August . . . It would appear then, as pointed out by Dr. R. M. Forde in his Medical Report, that the liability to infection occurs soon after the rains are established, lasting up to the end of November." In a report of the Malaria Expedition to Nigeria, by Drs. Annett, Dutton and Elliott,[7] the authors, in giving a chart, point out "how closely the numbers of cases of malarial fever follow the variations in the rainfall, and especially how the largest number of cases occur at a time when the rainy season has become fairly established."

The observations previously recorded as to the seasonal prevalence of *A. costalis* at Fort Johnston fall therefore into a definite line with those on the seasonal incidence of malaria not only in Nyasaland, but in British East Africa, Uganda, Tanganyika Territory, Mauritius and Southern Rhodesia, and also in some of the West Coast Dependencies.

As showing that the incidence of malaria may be correlated with the seasonal prevalence of particular Anophelines, evidence afforded by Sir Malcolm Watson in the Federated Malay States[8] may be cited. He remarks that "in Malaya, where the conditions are apparently so favourable to mosquitos throughout the year, one would hardly expect any marked seasonal variation in the malaria. Yet it is not so. It is true that the introduction of many non-immune people into a malarious place, at any time in the year, will forthwith be followed by a severe outbreak of malaria, showing, as we know, that there is usually a considerable number of active insects present. But apart from such accidental outbursts, there are definite seasonal variations which form curves or waves varying with the species carrying the disease." He gives a chart representing the average of the percentages of malaria treated each month from 1893 to 1900 in Klang Hospital, and explains the curve with its maximum in November as being due to malaria caused by *A. umbrosus*, and possibly other pool breeders. In another chart, showing the percentage of the labour force sick each month in 1913 and 1914 on an estate, quite a definite wave in the centre months of the year—from April to September—is referred to as being due to malaria of *A. maculatus* in the hill land. He states that "the larvae of *A. maculatus* are greatly reduced in numbers in the heavy rains of November, December and January, but in the two drier months, February and March, they appear in enormous numbers. Shortly afterwards the malaria wave appears." . . .

A factor other than the seasonal prevalence of any particular mosquito which might be held to account for the seasonal incidence of malaria is the direct effect of temperature on the development of the sexual cycle passed by the malaria parasite within the Anopheline female. For its successful completion Dr. Thomson[5] points out that a temperature of over 61° F. is necessary. Such a factor would hardly seem to be operative at Fort Johnston, for, apart from the absence of *costalis* during the season when a temperature so low for a tropical country may be reached, such cold is very transitory, and may occur at intervals only during two or three months in the year. On the West Coast it is still less probable that temperature is a decisive factor.

It was sought to confirm in Nyasaland the epidemiological evidence by the systematic dissection of numbers of the two common Anophelines captured in a locality in which there would be every chance of their being infected, namely, in a native village on the outskirts of Fort Johnston. Only those with fully ripe ova, indicating that they had received a meal of blood some days previously, were selected. This part of the investigation was initiated in March 1923, and continued during the twelve following months, the captures being made during March indiscriminately throughout the village, and thereafter in a hut in which, in addition to three native adults apparently free from malaria, three children showing a heavy infection with parasites, slept at night. The data hitherto obtained are necessarily meagre, for researches of more pressing importance rendered any exhaustive study out of the question, but they do afford some support for the view that *A. costalis* at certain seasons may play a greater part than does *A. funestus* in the causation of malaria. These data are as follows :—

Dissections of the two Anophelines.

	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Total of *A. funestus* dissected ...	11	1	65	45	26	—	28	41	15	123	21	54
Number infected ...	—	—	2	5	—	—	—	—	—	2	1	2
Total of *A. costalis* dissected ...	28	13	30	23	1	—	—	—	1	7	8	10
Number infected ...	—	—	1	3	—	—	—	—	1	2	3	—

Out of a total of 430 *A. funestus* twelve therefore showed malaria infection, whereas out of a total of 121 *A. costalis* ten were infected. Of these two only, both *funestus*, showed sporozoites, the rest zygotes. But the subject requires, of course, considerable further study.

Distribution of the two Anophelines in Nyasaland.

In connection with the study of the malaria problem in any particular country, it is of importance to ascertain precisely the topographical distribution of all the Anophelines. The data obtained may well have ultimate value in further enquiry into the aetiology of blackwater fever, since there is a widespread popular belief that there are certain localities, and indeed houses, in which the condition is especially likely to occur. The following data, collected by the writer, relate to the distribution of the two common Anophelines from north to south in Nyasaland, so far as the writer has been able to ascertain it. Most, those indicated thus (I.B.), were kindly furnished by the Director of the Imperial Bureau of Entomology ; others are from specimens lent by Mr. Smee, the Government Entomologist, from the collection in the Department of Agriculture in Zomba ; still other data were furnished with specimens sent into the laboratory by various friends. The list must be looked on as purely preliminary. The opportunities for a personal survey were necessarily limited owing to the exigencies of other work, and, as may be noted, the records relate mainly to the lower elevations ; they are astonishingly meagre in regard to the centres where the European population is largest—Blantyre and the Shire

Highlands, and Zomba; indeed, for Zomba itself, the capital town, there is the record only of a single male *costalis*. The necessity for a more extended mosquito survey is therefore obvious.

A. costalis.	*A. funestus.*
1. N. end of Lake Nyasa, about 1900, Dr. C. W. Daniels.	In same locality, 1900, Dr. Daniels.
2.	Highlands on each side of Lake Nyasa, 1900, Dr. C. W. Daniels.
3	Whole length of water system from north end of Lake Nyasa to Lower Shire River, 1900, Dr. C. W. Daniels.
4. Near Karonga, abt. 1,560 ft., 5.x.1913, Dr. A. G. Eldred, 1 ♀ (in Imp. Bureau Coll.).	Karonga, viii.1913, Dr. A. G. Eldred, 1 ♀ (in Imp. Bureau Coll.).
Karonga, x.1913, Dr. A. G. Eldred (I.B.).	Karonga, vii. 1910, S. A. Neave (I.B.).
Near Karonga, 4–5.x.1913, Dr. A. G. Eldred, 1 ♂, 1 ♀ (I.B.).	Near Karonga, 4–5.x.1913, Dr. A. G. Eldred, 1 ♂, 4 ♀♀ (I.B.).
5. Near Kaporo River, iii.1912, Dr. A. G. Eldred, 1 ♀ (I.B.).	Kaporo River, iii.1912, Dr. A. G. Eldred, 1♀ (I.B.).
6. Valley of S. Rukuru River, vi.1910, S. A. Neave, 5 ♀♀ (I.B.).	Valley of S. Rukuru River, vi.1910, S. A. Neave, 2 ♀♀ (I.B.).
Rukuru River, N.W. shore of Lake Nyasa, vi.1910, S. A. Neave, 3 ♀♀ (I.B.).	Rukuru River, Karonga, x.1913, Dr. A. G. Eldred, 1 ♂, 1 ♀ (I.B.).
7. Chinteche, Lake Nyasa, i.1913, Dr. J. G. Morgan, 1 ♂, 1 ♀ (I.B.); 13.i.1913, 2 ♂♂, 2 ♀♀ (I.B.).	Chinteche, Dr. J. G. Morgan, i.1913, 2 ♀♀; 13.i.1913, 2 ♂♂, 5 ♀♀ (I.B.).
8.	Kotakota, 21.xi.1910, Dr. J. E. S. Old, 1 ♂ (I.B.).
Kotakota, 20.iii.1923, abt. 1,600 ft., abt. 12° 15′ S. 34° 17′ E., I. C. Ramsay, 2 ♀♀	In same locality and by same captor on same occasion, 5 ♀♀.
9.	At Ndonda Pass, abt. 20 miles N.W. of Kotakota, abt. 3,500 ft., W. A. Lamborn, 6.xii.1923, 1 ♀.
10. Kasungu Boma, abt. 3,000 ft., 13° 2′ S. 33° 29′ E., 9.xii.1923, W. A. Lamborn, 1 ♀.	In same locality by same captor on same occasion, 2 ♀♀.
11. Kasache, Domira Bay, Lake Nyasa, 13° 20′ S. 34° 20′ E., abt 1,560 ft., 22.xii.1923, W. A. Lamborn, a few.	
12. Monkey Bay, abt. 1,560 ft., abt. 50 miles due N. of Fort Johnston, 20.iv.1908, Capt. Hallam Hardy, 1 ♀ (in B.M. Coll.).	
13. Mzeze, abt. 45 miles due N. of Fort Johnston, 23.iii.1923, abundantly, W. A. Lamborn.	In same locality on same occasion by same captor, sparingly.
14.	Mpondas, 2 miles N. of Fort Johnston, 25.iii.1910, Dr. A. H. Barclay, 4 exx. (I.B.).
Fort Johnston, in house, 24.iii.1910, 19.iv.1910, Dr. A. H. Barclay (I.B.).	In same locality by same captor, 25–28.ii.1910, 24.iii.10, and 19.iv.10, 48 ♀♀ (I.B.).
	Fort Johnston, 4–15.xii.1912, Dr. R. Bury, 6 ♂♂, 22 ♀♀ (I.B.).

A. costalis.	*A. funestus.*
Fort Johnston, 14° 27′ S. 35° 15′ E., abt. 1,560 ft., W. A. Lamborn, 1922–23–24, abundant in late wet season.	In same locality by same captor, 1922–24, abundant at all seasons.
15. Chipunga Estate, abt. 14° 47′ S. 35° 32′ E., abt. 4,000 ft., 2 ♀♀, 27.ii.1923, J. H. Faure.	In same locality and on same occasion by Mr. Faure, 5 females.
16. Between Fort Mangoche and Chikala Boma, abt. 4,000 ft., Dr. S. A. Neave, 23.iii.1900 (I.B.).	
17. A little S. of Lake Malombe, 1.viii.1911, Dr. J. B. Davey and Prof. Newstead, 1 ♀.	In same locality by same captors, numerous females, vii.–viii.1911.
	Upper Shire, in bedroom, 3.x.1911, Dr. J. B. Davey, 3 ♀♀ (I.B.).
18. Liwonde, 25.iv.1923, Major S. J. Pegler, 10 ♀♀.	In same locality by Major Pegler, 24–25.iv.1924, 10 ♀♀.
19.	Lake Chilwa, xii.1913, Dr. H. S. Stannus, 1 ♀ (I.B.).
20.	Matope, C. W. Mason, 4 ♀♀, 17.vii.1915.
21. Namiwawa, abt. 12 miles N. of Zomba, and perhaps two or three hundred ft. lower, 1 ♀, 13.iii.1915, 2 ♀♀, 6.xi.1915, C. W. Mason.	In same locality by same captor, 2 ♀♀, 20.vi.1915.
22. Zomba, vii.1913, Dr. H. S. Stannus, 1 ♂ (I.B.).	Zomba, 15° 22′ S. 35° 17′ E., 2,948 ft., C. W. Mason, 2 ♀♀, x.1914, 7 ♀♀, xi.1914, 2 ♀♀, xii.1914.
23. Misi, Chikala, 1,200 ft., near swamp, 93.i.1923, Dr. H. S. Stannus, 1 ♀ (I.B.).	In same locality by same captor, 13.i.1923, 2 ♀♀ (I.B.).
24. Chikala District, 1,200 ft., village near swamp, i.1913, Dr. H. S. Stannus, 2 ♀♀ (I.B.).	In same locality by same captor, i.1913, 1 ♀.
25. Lichenya River, Mount Mlanje, 2,300 ft., 4–17.ii.1915, S. A. Neave, 2 ♂♂, 7 ♀♀ (I.B.).	Mount Mlanje, 2,300 ft., 6–17.ii.1913, by same captor, 5 ♀♀ (I.B.).
Mlanje, 27.iii.1914, Dr. J. B. Davey, 1 ♀ (I.B.).	Mlanje, 10.xii.1910, 1.i.1913, Dr. S. A. Neave, 2 ♀♀ (I.B.).
26.	Gwazas, C. W. Mason, 12.v.1915, 1 ♀.
27. Chikwawa, Dr. Daniels, 1900.	In same locality, 1900, by same captor.
Chikwawa, C. D. Kashap, 6.iii.1923, 1 ♀.	
28.	Blantyre, 25.iii.1911, Dr. J. B. Davey, in house, 1 ♀ (I.B.).
29. Luchenza, Shire Highlands, 2 ♀♀, 13.v.1916, C. W. Mason.	
30.	Lower Shire River, iii.1911, Dr. J. E. S. Old, 2 ♀♀ (I.B.).
31. Chiromo, abt. 70 miles down river, Lower Shire, 1900, Dr. Daniels.	In same locality, 1900, by same captor.
32. Port Herald, rainy season 1912–13, Dr. J. E. S. Old, 1 ♂, 5 ♀♀ (I.B.).	In same locality by same captor, rainy season 1912–13, 1 ♀ (I.B.).
Port Herald, xii.1913 to i.1914, Dr. J. E. S. Old, 2 ♂♂, 5 ♀♀ (I.B.).	

It may be useful to summarize the conclusions reached in this paper as follows :—

1. *A. costalis* in the Shire Valley of Nyasaland is essentially a wet season species. This appears to be the case for Zanzibar and the Northern Provinces, Nigeria. The probability is that wider knowledge of the habits of the species will show that wet season prevalence occurs everywhere throughout its range.

2. The immature stages of this species are absent in the Shire Valley during the dry season, even though the breeding places that it favours in the wet season may contain water. It is suggested that the factors determining the presence of larvae may be the same as those which probably account also for the electicism of Anophelines as to breeding places.

3. *A. costalis* appears to be as particular in its selection of breeding places as many other Anophelines, particularly Oriental species, have been shown to be ; it remains a surprising fact that, while during many years every effort has been made to explain this by exhaustive studies of the grosser physical features of such places, so little effort has been made to seek an explanation by the study of the factors indicated, even in countries where there are first class laboratories and other facilities essential for such work.

4. *A. funestus* does not exhibit in the Shire Valley the seasonal prevalence so marked in the case of *A. costalis*, but further study of the question in other localities is called for.

5. Evidence has been adduced showing very definitely that the season for epidemic malaria coincides with the seasonal prevalence of *A. costalis*. The malaria of the late wet season is probably very largely *costalis* malaria.

6. Since *A. costalis* is essentially a breeder in small pools, and since breeding appears to cease entirely during the dry season, its control should be a comparatively simple matter. One may quote in this connection the opinion of a distinguished authority—Sir Malcolm Watson.[8] He remarks " *A. ludlowi* is a carrier of malaria in the flat land of the Malay Peninsula and elsewhere in Asia. It has been shown, however, that the thorough open drainage required to eliminate it is well within the range of practical sanitation ; so that there is apparently no reason why malaria carried by *A. costalis* could not be controlled ; or if the malaria is carried by *A. rossii* in Malaya, why it also could not be controlled."

It is extremely improbable that, however hard pushed as to its ordinary breeding places, the insect would avail itself of collections of water in which its larvae do not at present occur. This last is a vital point, and in view of the importance of the subject it may be well to cite some of the evidence on which such an expression of opinion rests. There is the case in the Federated Malay States of *A. maculatus*, which was shown by Watson in 1906 to be a carrier of malaria in nature, and has since been proved to be the chief infecting agent in the open hilly country. The insect used to breed in the open ravines round the capital town, Kuala Lumpur ; it has now been practically abolished by a system of subsoil drainage, and there has been a tremendous drop in the malaria rate. The insect, though quick to oviposit wherever there happens to be any little temporary defect in the drainage scheme, has never taken to breeding in other open waters.

The engineering work there undertaken has established the principle that, though measures against the breeding places of all species of Anophelines may be impracticable, at all events for the time being, a particular species may be almost eradicated by appropriate measures based on a thorough knowledge of its life-history and breeding habits. The importance of such a development of anti-malaria work can hardly be overestimated, and as affording some guide as to what may be expected, should suitable operations be directed against *A. costalis*, an account of the actual results, as described by Dr. A. R. Wellington, the Senior Health Officer in the

F.M.S., may well be here quoted. Referring to subsoil drainage as a measure against *A. maculatus* (in a locality teeming with other species of Anophelines) he remarks[9] :—

"The results of the drainage were most satisfactory, and in 1913 the European residential area was for the first time in seven years free from malaria, and it has remained free ever since.

"For the first time in the history of Kuala Lumpur, anti-mosquito works had been carried out under the authority of a board containing medical entomologists familiar with the mosquito it was desired to get rid of.

"The success was due to the complete eradication of *A. maculatus* breeding grounds, brought about by a system of drainage specially designed to deal with the problem. Particular mention must be made of the excellent work done by Mr. F. D. Evans, the Board's executive engineer. He was keenly interested in the subject, and he carried out the details of the scheme with such thoroughness and skill that no place was left suitable for *A. maculatus* to breed in. Strict attention to detail was absolutely essential, for with so efficient a carrier as *A. maculatus* even small and insignificant-looking pools of water are sufficient to keep the disease smouldering."

7. Though in the East African Protectorates there appear to be only two Anophelines of any importance, so that the entomological aspect of the malaria question must be far less complex than in many other countries, few details as to their bionomics and precise topographical distribution appear to be on record other than those made by Dr. Daniels along certain lines of communication in 1900. In the interests of public health and as a necessary preliminary to any rational attempt to effect the control of malaria, it is essential that their precise topographical distribution, their bionomics, seasonal prevalence and relative importance as vectors of malaria throughout their entire range in East Africa should be more clearly known.

A campaign directed more particularly against *A. costalis* appears to be called for equally with that which is at present being conducted against *Glossina*, for it is certain that the less obtrusive insect levies an even heavier toll on life and health.

In conclusion, the writer must express his appreciation of the ready help afforded by Mrs. A. G. Eldred, who during his various absences maintained very efficiently the routine work of the laboratory at Fort Johnston.

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OBSERVATIONS ON PALESTINIAN *ANOPHELES*.

By Oscar Theodor,
Entomological Assistant, Malaria Research Unit, Haifa.

Anopheles pharoensis.

This mosquito has only once been recorded from Palestine, namely, by Mr. P. J. Barraud (Tabgha 1918), and it was thought to have been introduced from Egypt by a transport of E.L.C. Mr. P. A. Buxton and I failed entirely to find it during two years' collecting.

Soon after my transfer to the Malaria Research Unit (August 1923) I received a large number of mosquitos from the anti-malaria inspectors of the Unit for identification, and among them a specimen of *A. pharoensis* from a house in Hedera. From August to December about twenty specimens were found in different parts of the country. The following are my records :—Hedera, 15.viii.23, one ♀; Shuneh, 31.viii.23, one ♀; Zicron district, x.–xi.23 (Insp. Ben-Israel), ten ♀♀; Tel-Joseph, 8.x.23, two ♀♀; Beth-Alfa, 28.x.23 (Insp. Turban), one ♀; Dagania, 16.x.23 (Insp. Paz), two ♀.

During the same period I obtained some larvae from Nahr ez-Zerka, near Shuneh, the striking inner shoulder-hairs of which attracted my attention. These proved also to be *A. pharoensis*. Subsequently I bred *A. pharoensis* from larvae found in Hedera and also obtained one larva from Wadi Musrara, near Jaffa.

Regarding the distribution of the mosquito, it appears that it has always been found in places close to the Kantara–Haifa–Semakh railway. It has never been caught at a distance of more than 3–4 km. from the railway, so that it is still a question whether the mosquito has not been brought in by the increased traffic on this line after the war. This species is quite common in Kantara during the autumn, and I have often observed *Anopheles* of different species coming into the train towards evening and travelling with it for hours. On the other hand, the finding of larvae of *A. pharoensis* shows that there are conditions in Palestine suitable for its development, so that it may well establish itself as a native species.

As there are in the available literature no illustrations of the early stages of *A. pharoensis*, I give some drawings of the egg (fig. 1, *c*) and the very characteristic shoulder hairs of the larva (fig. 2, *b*). By means of these and the combination of the simple antennal hair and the branched outer clypeal hair, the larva may be easily recognised. Some remarks on the pupa will be given below.

Anopheles elutus.

In December 1923 I brought home a large batch of *A. elutus* from the Zichron district, some of which were sent by Dr. Kligler to Prof. Grassi in Rome. In examining the eggs, laid in the cage, I was surprised to find that these had air-floats, similar to those of *A. maculipennis*. Shortly afterwards Prof. Grassi informed us that he also had obtained eggs with air-floats from the mosquitos sent him, and he published a short note on his observations. Subsequently I examined about 80 egg-batches and also nearly ripe eggs, dissected out while searching for malaria parasites. All the eggs examined during the winter period and until the beginning of May possessed air-floats and also the unripe eggs 2–3 days before deposition. There was a progressive decrease in the size of the air-cells until they disappeared completely at the beginning of May. Some of the stages are figured below. The largest floats were still much shorter and smaller than ordinary *maculipennis* floats. They became gradually smaller during the spring, until in the last stages the egg, seen from above, did not seem to possess air-floats, but when seen in profile there

was a slight sinuation and broadening in the surrounding rim (fig. 1, *e*). Finally this also disappeared, and the first egg without a sign of an air-float was seen at the beginning of June. Subsequently only a few eggs with small floats were observed (figs. 1, *d–f*).

Fig. 1. Eggs of Palestinian *Anopheles:* (*a, b*) *A. sergenti*, Theo.; (*c*) *A. pharoensis*, Theo.; (*d–h*) *A. elutus*, Edw., with air-floats of varying sizes; (*i, k*) *A. superpictus*, Grassi; (*l*) *A. elutus*, transverse section; (*m*) *A. superpictus*, transverse section.

At first we thought that both *A. maculipennis* and *A. elutus* might occur in Palestine. Gravid females were therefore separated until the eggs were deposited, and the mosquitos with their respective eggs were sent to Mr. F. W. Edwards, who found that all of them were *A. elutus*, though the eggs all had air-floats. The eggs of the same batch were as a rule uniform in size and shape, though slight variation occurred, especially in spring.

As to the cause of this interesting phenomenon, we at first thought that it might in some way be due to the salinity of the water, particularly since the mosquitos came from a region where *A. multicolor* bred freely and where there was certainly brackish water. That the phenomenon might be due to salinity had already been suggested by Mr. Edwards in his paper on palaearctic mosquitos. Later, however, we received mosquitos from the Jordan valley, which also laid eggs with air-floats, although there was no salt water in the whole neighbourhood.

The appearance of the floats during the autumn and their disappearance in the spring, and their slow decrease with the rising temperature, suggest a relation to a temperature factor. The fact that in the hot Jordan valley the floats disappeared a few weeks earlier than they did along the coast also points to the influence of temperature. The experiments of Fischer and Standfuss on the influence of heat and cold on the wing colour and wing markings of butterflies and the experiments of Przibram on rats show to what extent temperature may change morphological structures, changes which may persist through several generations. Also the observations of Martini on the variation of the number and size of the maxillary teeth of *A. maculipennis* and *A. elutus* in different countries suggest that the observed variations may be caused in the first instance by climatic factors, *e.g.*, temperature. I hope during next winter to determine some of the factors which are effective in this relation.

The Larva of Anopheles multicolor.

I examined a long series of larvae of this species and found that the character on which Mr. P. A. Buxton separated it from *A. superpictus* and *A. sergenti* cannot be maintained. In all the larvae the innermost shoulder hairs are of the same shape as in *A. superpictus* and *A. sergenti*, *viz.*, branched from the base. The larva is on the whole extremely similar to that of *A. superpictus*, but there are differences in the head

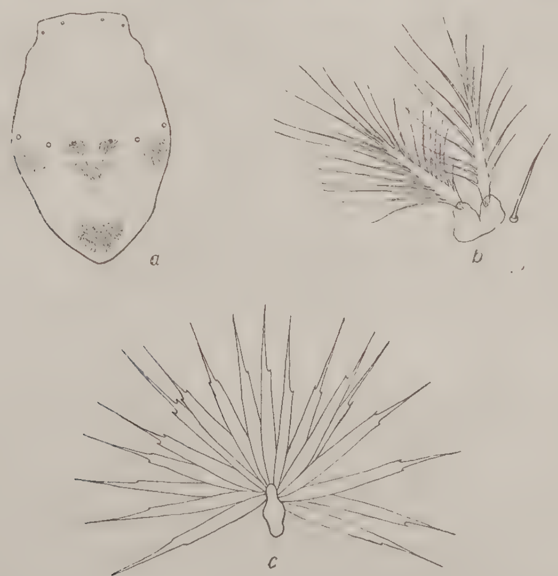

Fig. 2. *Anopheles* larvae: (*a*) vertex of head of larvae of *A. multicolor*, Camb.; (*b*) right innermost shoulder hair of larva of fourth stage larva of *A. pharoensis*, Theo.; (*c*) palmate hair of *A. multicolor*.

markings and the palmate hairs. In *superpictus* there are three small spots on the vertex, and the base of the inner and middle post-antennal hair is pale, while in *multicolor* there are two dark spots at the base of these hairs, as well as the median spot that occurs in *A. superpictus*, so that there are three spots, forming together a narrow triangle (fig. 2, *a*). Sometimes all these spots coalesce into a large black mark, covering most of the vertex, a feature which I have never observed in *A. superpictus* or *A. sergenti*. In this case the ventral side of the head is also blackish. The leaflets of the palmate hairs are not so strongly shouldered as in *A. superpictus* and their filament slowly tapers towards the apex, thus becoming much more similar to the leaflets of *A. bifurcatus*; but the teeth stand more closely together on about two-thirds of the length of the leaflet, and not equally distributed over its whole length as in *A. bifurcatus* (fig. 2, *c*). The distribution of the palmate hairs, the number of the leaflets, the shape of the abdominal plates, etc., are exactly the same as in *A. superpictus*.

Pupae of A. multicolor and A. pharoensis.

I succeeded in getting one pupa of *A. pharoensis* and many of *A. multicolor*, so that I can now compare the pupae of all the species of the *Myzomyia* group, and I must say that it seems to me rather difficult, if not impossible, to distinguish between the pupae of this group with certainty. All the characters vary considerably in each species, *e.g.*, the length of the seta C of the seventh abdominal segment. The seta on the blade of the paddle is branched in *superpictus* and *sergenti*, branched or simple in *multicolor*, and simple in the one specimen of *A. pharoensis*. The shape of the

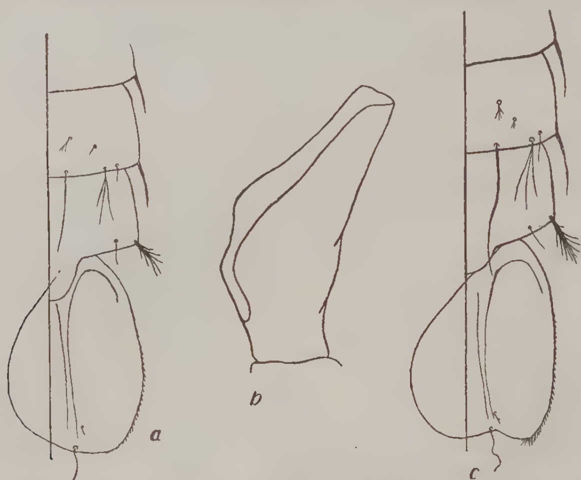

Fig. 3. *Anopheles* pupae: (*a*) 7th–9th segments of *A. pharoensis*; (*b*) trumpet of same; (*c*) 7th–9th segments of *A. multicolor*.

paddle is also variable; that of *A. multicolor* resembles in its angular form very often that of *A. sergenti*, but is larger as a rule; however, paddles of the rounded form of *A. superpictus* are not uncommon. Perhaps the sinuation at the base of terminal paddle hair gives a specific character for *A. multicolor* (figs. 3, *a*, *c*). The trumpets of *A. superpictus*, *sergenti* and *multicolor* are very much alike, only that of *A. pharoensis* is relatively shorter and broader (fig. 3, *b*). Measurements of the trumpets and paddles of *A. multicolor* and *pharoensis* are given to complete Dr. Buxton's table in "Applied Entomology of Palestine" (Bull. Ent. Res. xiv, p. 312).

Species.	Paddles. Length in mm.	Length to breadth (=1).	Trumpets. Length in mm.	Length of meatus to total length.
A. multicolor	0·8–0·93	1·45 : 1	0·43–0·56	0·25 : 1
A. pharoensis ...	0·78	1·56 : 1	0·48	0·20 : 1

Anophelines sergenti.

I have compared adults of *A. sergenti* and *A. culicifacies* (which Mr. P. J. Barraud was kind enought to send me) and can detect no difference other than that already noted by Mr. Edwards, *viz.*, the number of pale spots in the wing fringe. Mr. Buxton compared the larvae of these species and found but a slight difference in the head markings. However, if the drawing in Patton's "Medical Entomology" is exact, differences exist between the eggs.

Patton describes the egg of *A. culicifacies* as follows :—Egg with narrow rim on upper surface, air-floats not extending up to it. The profile view of the egg shows the air-float right in the middle of the side surface of the egg, leaving an equal space between air-float and upper limit and air-float and lower limit. In *A. sergenti* there is a broad border of air-floats partly covering the upper surface, leaving only a small, characteristically shaped space (fig. 1, *a*, *b*).

Anopheles superpictus.

Though it seems rather unlikely that the egg of *A. superpictus* should not be described, I cannot find any description of it in the literature available here, except a short remark by Prof. Grassi, which I quote, after Martini. "The eggs are smaller than those of *maculipennis* and have smaller air-floats. They rest on the surface of the water in about the same order as those of *maculipennis*." Mr. Buxton also assumed that the egg has not been described.

The egg (figs. 1, *i*, *k*) represents an interesting intermediate form between those of *A. sergenti* and *A. elutus*. As seen from above, there seems to be no difference from the *elutus* egg, except its smaller size, but in fact it is very distinct. The outline of the egg of *elutus*, seen in profile, is limited by two convex lines, the lower one being more strongly curved than the upper one. A narrow rim of air-cells surrounds the middle of the egg, leaving a part of the egg visible above it. In the egg of *sergenti* and *superpictus*, seen in profile, the lower limit is still more strongly curved, but the upper one is distinctly concave. In *superpictus* the rim of air-cells surrounds the upper surface of the egg like the railing on a ship's deck. Thus, in the profile view the upper limit of the air-cells is the uppermost line, next comes the upper limit of the egg body (visible through the air-cells), and then the lower limit of the rim. The different structure of the air-cells in the two species is best seen in a transverse section, as shown in figs. 1, *l*, *m*. Sometimes the upright rim in *superpictus* is flattened down, thus appearing much broader than in normal eggs (dotted line in fig. 1, *i*).

The ectochorion of the egg of *A. elutus* forms a finer irregular reticulation on the upper surface of the egg and a coarser, more regular hexagonal one on the lower surface. In *superpictus* the reticulation on the upper surface is similar to that of *elutus*, but there is no trace of the hexagonal pattern on the lower surface, the membrane being uniformly smooth all over the egg.

Measurements of Eggs.

Species.	Length in mm.	Breadth without air-cells.	Depth.
A. pharoensis ...	0·6	0·12–0·14	0·14
A. sergenti ...	0·45	0·12	0·10
A. superpictus ...	0·50	0·12	0·11

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DESCRIPTIONS OF TWO SPECIES OF COCCIDAE FEEDING ON ROOTS OF COFFEE.

By F. Laing, M.A., B.Sc.

Ortheziopa, gen. nov.

Belonging to the Ortheziinae. Antennae four-segmented, situated on low tubercles; eyes well developed and situated close to but not fused with the base of antenna. Tibia and tarsus distinct, tibia exceedingly short compared with tarsus. Larva with antennal and limb characters of adult. Genotype *O. reynei*, sp. n.

The genus is probably most nearly allied to *Ortheziola*, Sulc., from which it differs in the non-fusion of the eyes to the base of the antennae and of the tibia and tarsus.

Ortheziopa reynei, sp. n. (fig. 1).

Adult ♀ ovate, about one-fifth longer than broad. Antennae four-segmented, with a few short, spiniform hairs scattered along its whole length; tubercles ring-like; segment I robust, breadth at base subequal to length, II considerably shorter and more slender, III subequal to or slightly longer than IV, slender, IV club-shaped, with a strong apical seta nearly twice the length of the segment, a much shorter subapical one, and a lateral, rather slender falciform spine; proportions of segments, 22, 16, 40, 37. Rostrum prominent, stout, acute-pointed, nearly twice as long as broad, a few short spines at apex. Eyes well developed, situated close to, but not fused with, basal segment of antenna. Legs long and strongly developed; trochanter completely fused with femur; tibia and tarsus distinct, but the two segments are so closely united that there is probably no independent movement; tibia very short, about

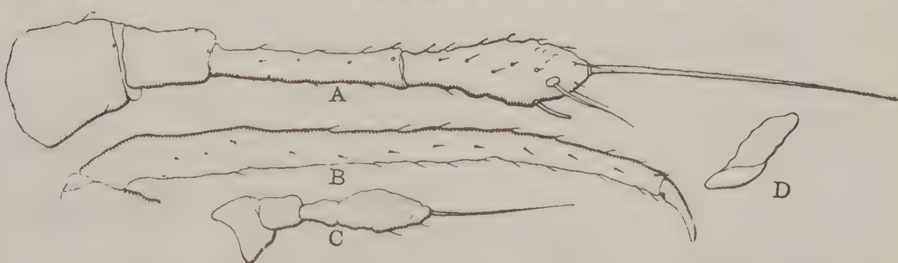

Fig. 1. *Ortheziopa reynei*, sp. n., adult ♀: A, antenna; B, tibia and tarsus; C, antenna of larva; D, eye.

one-third length of tarsus, the two together considerably longer than femur; claw robust, without denticules; no tarsal digitules; ungual digitules represented by two very short spines; the whole limb with numerous short spiniform hairs. Anal ring with six moderately developed setae. Thoracic spiracles inconspicuous and obscured by the spines of a marginal gland tract amongst which they are situated; abdominal spiracles wanting. Spiniform gland tracts very similar to those of other members of the subfamily, covered with straight or slightly curved sharp pointed spines and with large circular pores in the clear areas between, these pores most numerous in posterior region. Total length approximately 1 mm.; breadth 0·8 mm.

Dutch Guiana: on the roots of coffee (*A. Reyne*).

As mounted specimens only have been submitted, I am unable to make any remarks regarding the characters of the marsupium. The dermal characters, in particular the spiniferous gland tracts, are very similar to what are found in such species as *Orthezia cataphracta*, Shaw, and *O. urticae*, L., and doubtless the marsupial appearance will be much the same in *O. reynei* as it is in those species.

Rhizoecus coffeae, sp. n. (fig. 2).

Adult ♀ broadly ovate, specimens when mounted being very little longer than broad. Antennae five-segmented, basal segment strong, well developed, almost square-shaped, the three following segments subequal in length, broader than long; fifth segment very long, nearly as long as the other four segments together, with three very strong falcate spines, one situated on the inner and two on the outer margin, a smaller one situated medianly near the base, and a strong straight spine subterminally; numerous long slender setae on all the segments. Eyes either absent or not noticeable. Limbs normal, the articulation of tibia and tarsus rather difficult to distinguish, the two together in the front pair of limbs subequal to the femur, the tarsus being subequal to or a little longer than the tibia. Claw strongly developed,

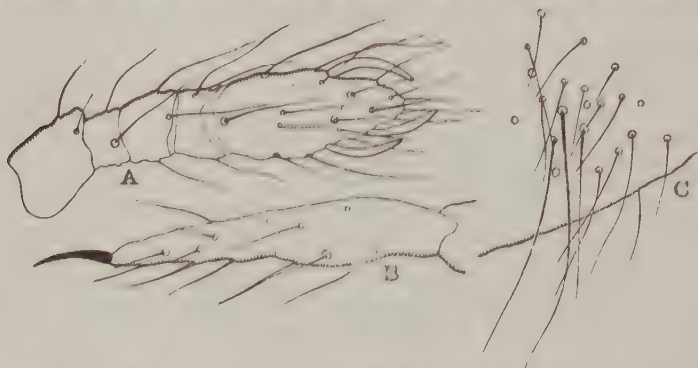

Fig. 2. *Rhizoecus coffeae*, sp. n.: A, antenna; B, tibia, tarsus and claw; C, caudal cerarius.

approximately one-third the length of tibia and tarsus together; two strong spinose setae near the middle of the inner margin of tarsus. Caudal cerarii only present, composed of four very long slender setae, the longest of which is nearly three times length of anal ring setae, and eight or nine shorter setae of approximately half their length. Dorsum with numerous small circular pores and short slender setae. Dorsal osteoles distinguishable but not conspicuous. Length 1·3 mm.; breadth 1·15 mm.

DUTCH GUIANA: Paramaribo, on roots of coffee (*A. Reyne*).

We have separated this species from *R. eloti*, Giard (the location of the types of which we have been unable to trace), on the strength of Giard's statement that his species has but three falciform spines on the antennae and also in the shape and size of the two species. *R. coffeae* is almost circular in shape, which is unusual in members of this genus.

ON SOME EULOPHID PARASITES (HYM., CHALCIDOIDEA) OF THE OIL PALM HISPID BEETLE.

By JAMES WATERSTON, B.D., D.Sc.

Oil palms in West Africa are periodically subject to somewhat serious attacks by *Coelaenomenodera elaeidis*, Maulik, a beetle of the family HISPIDAE, which mines the leaves. From the early stages of this beetle Mr. G. S. Cotterell, Assistant Entomologist, Gold Coast, has bred several Chalcidoid parasites, which were forwarded to the Imperial Bureau of Entomology and form the subject of the present paper.

Family EULOPHIDAE.

Subfamily EULOPHINAE.

Genus **Dimmockia,** Ashm.

Amongst the larval parasites were seven examples of an Eulophid, apparently referable to Ashmead's genus *Dimmockia*, in which, up to the present, only an American species has been included. Mr. A. B. Gahan, in confirming this conclusion, has increased my indebtedness to him by forwarding a specimen (♀) of the genotype compared with the type for study. Some additional notes on the genus may be given.

♀. Head thin, very distinctly broader than deep, frontal orbits straight, slightly divergent ventrally; toruli just above base line of eyes. Antenna 10 jointed, with two ring joints.* Propodeon with central and lateral keels (subparallel) well developed. Fore wings bare on rather over the basal third.

♂. Scape swollen, with large pincushion-like sensorium. The appendages on joints 1–3 of the funicle are genuine processes of the joints themselves, and carry similar sensoria. Abdomen with pale basal blotch.

Dimmockia aburiana, sp. n. (figs 1 and 2).

♀. Head, thorax and coxae blackish, dull, a little shining along the posterior edge of the pronotum and on the axillae. Propodeon like thorax, but with some metallic green reflections. Bristles of thorax pale. Abdomen with slight metallic green reflections on anterior third, more purplish or dull cupreous posteriorly. Antennal scape pale, pedicel infuscated, especially dorsally; funicle, palpi, and basal two-thirds of mandibles blackish brown; mandibles apically yellow, with lower tooth ferruginous. Wings hyaline, nervures pale. Legs with trochanters pale (except in fore legs, where they are a little infuscated), femora to about one fourth from apex blackish and for the rest pale.

♂. Similar to ♀, but only the basal one fourth of the scape is pale; rest of antenna brown. Reflections on propodeon slight and on abdomen confined to the middle (anterior) and sides of the first tergite. The pale spot is large, extending from just beyond the middle of tergite 1 (3) to the middle of 3 (5). Seen from above it covers entirely the intervening tergite, though the overlaps are chitinised and infuscated.

* Ashmead says "10-jointed with one ring joint." The specimen of the genotype which I have examined unfortunately lacks antennae, but apparently Ashmead reckoned as a joint the sub-articulate cap of the club. If so, the formula should be 11 joints. The 2nd ring joint of the ♂ antenna is concealed in the base of the 1st funicular.

♀. Head joint wider than thorax; much wider (9 : 7) than deep. Frons broad, at its narrowest occupying five-ninths of the total breadth. Base line of eyes two-thirds the breadth. Toruli distinctly above base line, at one-third the depth above the clypeal edge, broadly oval (8 : 7) and separated by one and a quarter times their long diameter and from the orbits by two diameters. Lateral ocelli nearly a diameter from the orbits. Clypeal edge straight, eyes bare, prominent, in depth half, in width two-ninths the breadth of the head. Scapal impression smooth, extending in an elongate triangle to the anterior ocellus; surface elsewhere finely reticulate and pattern hardly raised.

Labrum (1 : 3) simple, straight-edged, with six fringing bristles (fig. 1, *c*); maxillary palpi with two joints (9 : 11), terminal bristle longer than joint; labial palpi 10; mandible (see fig. 1, *b*). Antenna (fig. 1, *a*), scape (6 : 1) longer than pedicel (8 : 5), ring joints and first funicular together; first funicular joint very distinctly the longest; proportionate lengths of funicular joints, 21 : 14 : 13, and club 12 : 10, breadths, 9 : 10 : 11, and club 11 : 7. Sensoria as in fig.

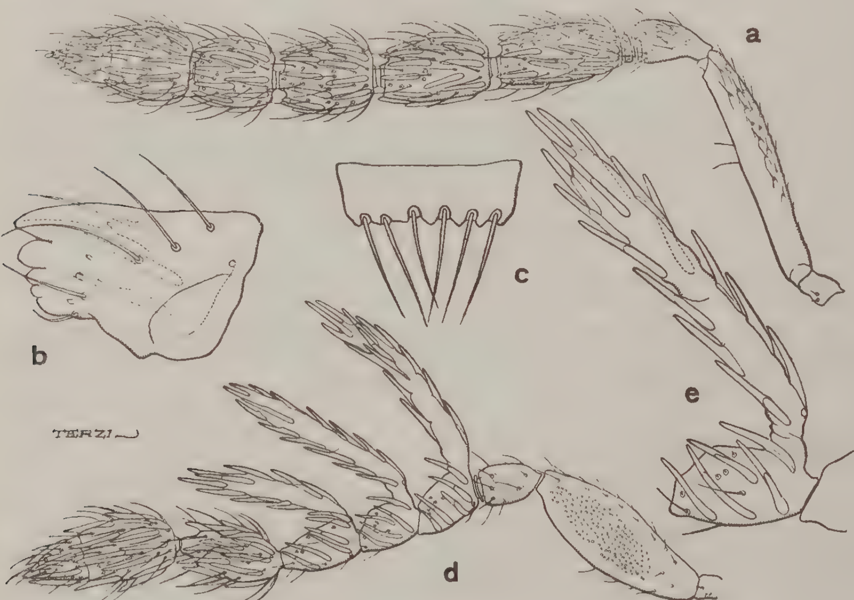

Fig. 1. *Dimmockia aburiana*, sp. n.: (*a*) antenna, ♀; (*b*) mandible, ♀; (*c*) labrum, ♀; (*d*) antenna, ♂; (*e*) second funicular joint, ♂.

Pronotum with strongly raised, rather coarse, pattern on the rounded posterior half; the descending anterior half much smoother, but with four concave patches of coarse reticulation medianly behind the head; spiracular notch distinct, sides (overlaps) concave with coarse sculpture, six major bristles in posterior row—one of them above spiracle. Mesonotum sculptured like posterior half of pronotum, with six major bristles in two longitudinal rows (3 : 3) on scutum, and four or five shorter ones on the undifferentiated parapsides. Axillae bare, with pattern finer and less raised. Scutellum, except in middle, with rather coarse sculpture; four bristles, one behind the axilla almost on suture, and the other above the crenulate hind margin. Sternopleurae (fig. 2, *b*). The foveae of the prepectus and pleurae should be noted. Propodeon (*vide infra* and fig. 2, *c*).

Forewings (fig. 2, *a*) (7 : 3) submarginal : marginal : radius : post marginal, approximately 12 : 11 : 2 : 3 ; 6–7 bristles on radius. Hindwings 7 : 2.

Legs : coxa of fore and hind legs, about 2 : 1 ; femur, fore 13 : 3, mid 14 : 3, hind 4 : 1 ; tibia, fore and mid, about 10 : 1, and broader (7 : 1) in hind legs ; tarsus, in fore and mid legs the first joint one-fifteenth longer, in hind legs one-fifth shorter than second joint. Fore femur with a row of nine long bristles (one just before the apex longest and stoutest) on outer ventral aspect ; comb of first tarsal joint with seven spines ; on mid femur only the long subapical bristle ventrally. Hind legs, tibial ventral row 12, apical comb 12 spines. All the tarsal ungues bear a long bristle dorsally rising from a well-marked preapical notch.

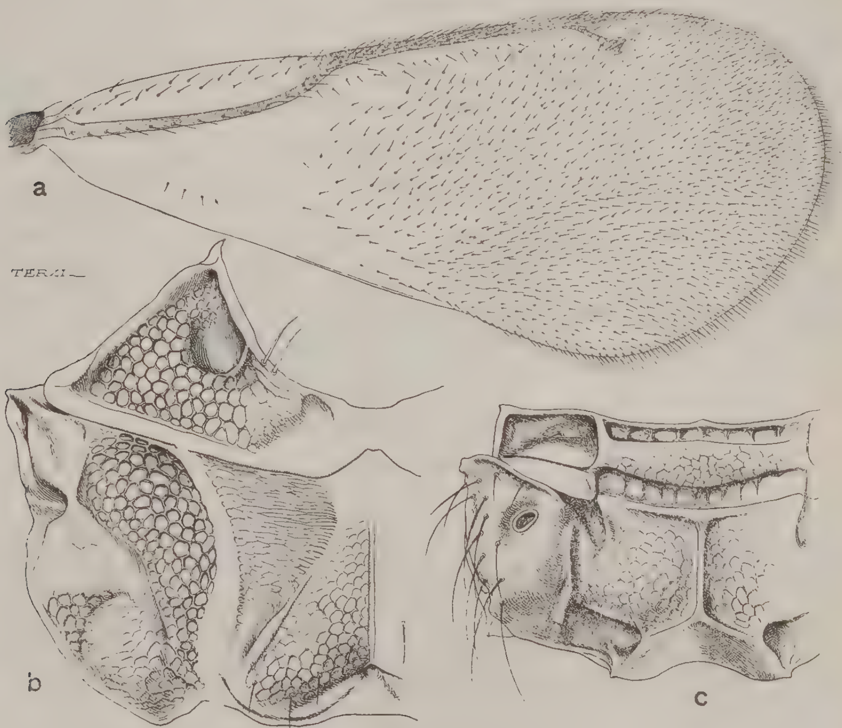

Fig. 2. ***Dimmockia aburiana***, sp. n., ♀ ; (*a*) fore wing ; (*b*) mesosternopleurae and prepectus ; (*c*) propodeon.

Abdomen pointed oval ; 1st (3rd) tergite about one-fourth longer than the others, which are subequal.

Length 1·2–2·3 mm.; alar expanse 2·2–4·2 mm.

The larger examples with a forewing length of about 1·8 mm. appear to be of the normal size.

♂. Head with frons broader, at narrowest occupying two-thirds of the width ; base line of eyes three-fourths the width. Toruli rounder and wider apart (one and a half diameters) than in ♀. Lateral ocelli nearly two diameters from orbits.

Antenna (fig. 1, *d*, *e*) ; scape (5 : 2) swollen, as long as pedicel, ring joints (2) and first two funicular joints together ; pedicel (3 : 2) ; funicle length, 10 : 11 : 14 : 16, and club 14 : 10 ; the width varies from 6 (on 3rd joint) to 9 (on club).

Legs with the femora relatively thicker (deeper) than in the ♀, and with 3–4 fewer bristles or spines in the rows.

Abdomen : lengths of tergites approximately 7 : 4 : 4 : 5 : 5 : 4.

Length, about 1·7 mm. ; alar expanse, about 2·8 mm.

GOLD COAST : Aburi, 1923 (*G. S. Cotterell*).

Type.—♀ in the British Museum, one of a series of three ♂♂ and six ♀♀ bred from larvae of *Coelaenomenodera elaeidis*, Maul., var. The ♂♂ were reared in September, the ♀♀ in October. A paratype ♀ has been deposited in the United States National Museum, Washington.

In *D. aburiana*, sp. n., the side keels (folds) of the propodeon (fig. 2, *b*) are parallel to one another and to the mid keel (when looked at from above in a carded specimen slightly *divergent* posteriorly) ; the diameters of the areas on each side of the mid keel bisect one another. Spiracular sulcus deep and pit-like at the anterior end of the lateral fold. The oval spiracle is remote both from the side keel and from the anterior edge. Surface of inner area smooth and gleaming, the pattern perceptible indeed but raised only near the mid keel posteriorly. Outer (spiracular) area smooth.

In the genotype (*D. incongruus*, Ashm., 1904) the side keels *converge* considerably posteriorly ; the diameters intersect unequally ; spiracular sulcus not forming a deep pit at the end of the fold ; spiracle subcircular and practically touching the side keel and the anterior edge. Surface of side areas scaly reticulate, pattern rather strongly raised. Outer (spiracular) area rough, not smoothly contoured.

Subfamily ENTEDONINAE.

Cotterellia, gen. nov.

♀ ♂. Head large, transverse, just wider than thorax ; occiput carinate ; eyes large, densely pubescent, extending from the occipital edge nearly to the mouth edge, *i.e.*, malar space very short ; orbits divergent on vertex, sub-parallel and straight on upper and gently concave on lower frons. Face inflexed at about one-third from the anterior ocellus to the clypeal edge—the inflexion forming a distinct ridge across the middle two-thirds of the frons. Labrum simple, transverse, with numerous long fringing bristles ; mandibles similar, apically bidentate ; maxillary and labial palpi each with one joint. Antenna 8 (10) jointed, viz., scape, pedicel, three ring joints, three in funicle and two in club—the apical joint awl-like.

Pronotum transversely ridged ; parapsidal furrows deeply percurrent, each expanding into a triangular hollow in the parapside before the suture. Between these lateral hollows is a depression of the scutum reaching forward to about one-half from the suture. Scutellum large, subequal to the scutum in length, with a strong ridge on each side before the edge ; posterior margin crenulate. Prepectora hollowed, crossed by one or two slight rugae and forming a deep depression at their median fusion.

Propodeon with a strong median keel ; from above there are two blunt postero-lateral angles ; on each side of median keel a pentagonal area enclosed by keel, hind edge of metathorax, lateral keel (or fold) and hind edge, which is strongly raised. Spiracles rather small, oval, remote from lateral keels and placed far forward—almost on edge. Abdomen shortly petiolate wider than long (♀) or just longer than wide (♂), oval in ♀, long oval in ♂, with characteristic punctation (*vide infra*).

Cotterellia podagrica, sp. n. (figs. 3, 4).

♀. Black, whole surface of body more or less metallic; on head and thorax anteriorly dark blue with green reflections, becoming violet on scutellum; reflections of abdomen purplish, especially anteriorly; ventral reflections mainly dark green. Wings (except shortly near radix, which is hyaline) completely and evenly infuscated, the forewings the darker. First three tarsal joints white or (fore legs) pale.

♂ like ♀, but less brilliantly coloured; thoracic reflections chiefly faint dark green; on abdomen mainly at base (on first tergite) dark purplish. First three joints of fore tarsus infuscated, though not black like the fourth; wings less deeply infuscated.

♀. Head much wider than deep (10 : 7). Inter-ocular distances (*a*) on occipital edge 5 : 8 of width, (*b*) across posterior ocelli 1 : 2, (*c*) at frontal ridge about 2 : 5, (*d*) across facial inflexion not quite 1 : 2, (*e*) across toruli 3 : 8, (*f*) base line of eyes 1 : 2. Vertex and frons down to ridge and along orbit, to level of toruli, with closely set umbilicate punctures. Toruli at two-thirds from transverse ridge to mouth-edge, oval, moderate-sized, two-thirds as long as the malar space and a little wider apart

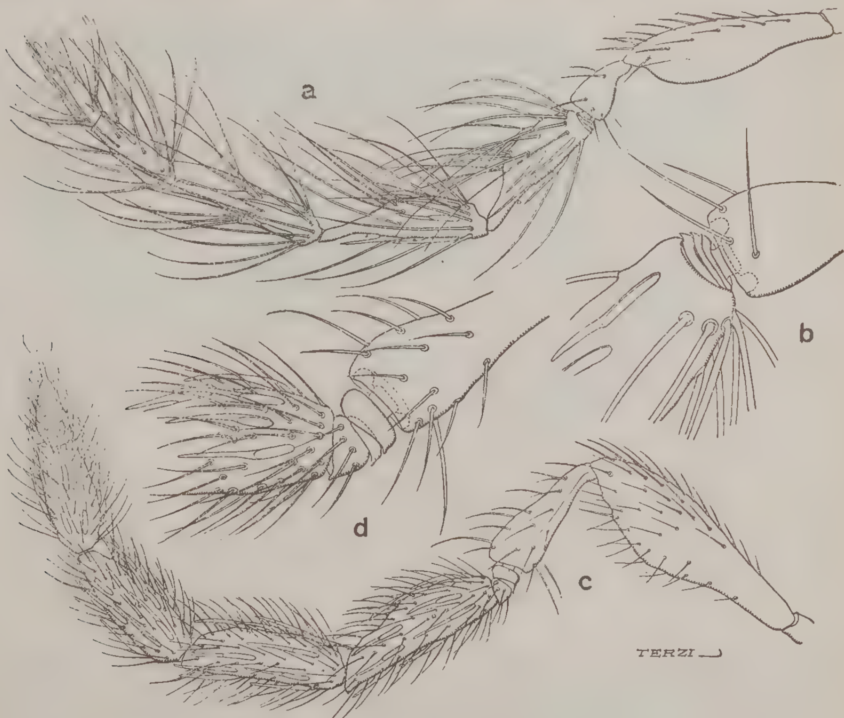

Fig. 3. *Cotterellia podagrica*, gen. et sp. n.: (*a*) antenna, ♂; (*b*) ring joints, ♂; (*c*) antenna, ♀; (*d*) ring joints, ♀.

than from the orbits. Above the toruli a well-defined narrow triangular deeply punctured area extends upwards with its apex at the middle of the transverse ridge. On each side the facial impression is coarsely reticulate and strongly raised, this sculpture merging with the heavier punctation along the orbits. Clypeus medianly

swollen, smooth with deep punctures along the straight mouth-edge, and a group of similar punctures on each side, which do not, however, extend over the narrowly gleaming lower orbits (*i.e.*, below level of the toruli).

Labrum (about 1 : 2) with edge slightly convex, with some 20 fringing bristles, of which the longest (median) are half as long again as the sclerite itself. Mandibles (fig. 4, *b*) (15 : 13); basal ventral lobe large; above second tooth a rounded cutting edge.

Antenna (fig. 3, *c*, *d*) about 1·2 mm. long. Scape (3 : 1) widest above one-half and narrowed basally, not quite twice (11 : 6) as long as the pedicel (5 : 2); the latter narrowed in proximal half. First ring joint normal, rather large, bare; second small, narrow, wedge-like, bare; third large, triangular in profile, with two rows of bristles similar to those on normal funicular joints and like the second, articulating well above the centre (fig. 3, *d*). First two funicular joints subequal (72 : 70), third (62); club joints subequal (45), the terminal process of the second occupying one-third of the length. In the same scale the breadth of the scape and funicle is about 25, diminishing to about 18 at the club suture. Bristles and sensoria as in figure.

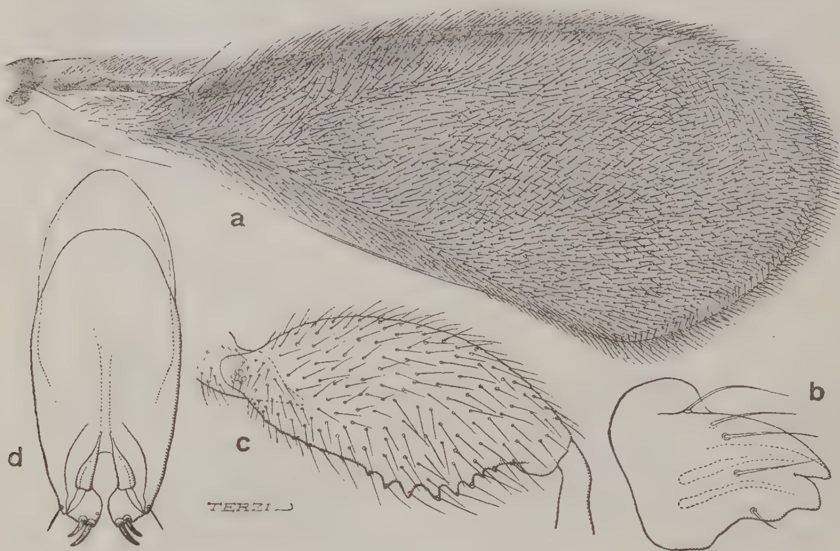

Fig. 4. *Cotterellia podagrica*, gen. et sp. n.; (*a*) fore wing, ♀; (*b*) mandible, ♀; (*c*) hind femur, ♀; (*d*) genitalia, ♂.

Thorax stoutly built; mesonotum with coarse duller leathery sculpture, the hollows shining, admedian aspect of lateral keels of scutellum crenulate, mesosternum deeply and closely umbilicately punctate medianly and on posterior half towards sides; anteriorly dull with fine punctures but antero-laterally shining and smooth. Mesepisternite shining, the femoral impression dull, raised reticulate; epimeron narrow with 3–4 deep punctures. Propodeon with areas about mid keel smooth medianly, with a few transverse rugae vertical to the keel.

Forewings (fig. 4, *a*) (17 : 7), length 2·2 mm., breadth 0·9 mm. Submarginal : marginal : radius : postmarginal, 32 : 100 : 8 : 15. Three bristles on submarginal, one at about one-half and the others nearer the base, one bristle on slight prominence at crossing of submarginal and marginal. Radius short with 2–3 bristles. Hind

wings (4 : 1), length 1·75 mm., breadth 0·43 mm. Slightly less than one-fourth the basal surface is bare, the rest almost as densely pilose as the forewing. The bare area ends in a straight line at right angles to the submarginella. From apex to beyond one-half posteriorly the edge of the wing (immediately behind the fringe) is narrowly bare. The discal ciliation when it begins again runs parallel with the hind edge and the cilia bounding the bare lines are subparallel to one another.

Forelegs, length nearly 2 mm. ; coxa (3 : 2) normal, pyriform, robust, coarsely raised reticulate ; femur (3 : 1) stout and a little swollen, with well defined antero-ventral tibial groove ; tibia a little longer than femur, widest (11 : 2) at about one-third from apex, contracting on apical third to 9 : 1 at apex ; tarsus 30 : 40 : 33 : 72, on antero-ventral edges with 4, 3, 2, 5 spines respectively, the fourth joint stout and about half broader than the others ; empodia large, claws large and strong, as long as the first tarsal joint and explanate on basal two-thirds, where the breadth is half the length. Mid legs, about 2·3 mm. ; femur (10 : 3) stout but more slender than in foreleg ; tibia (15 : 2) slender, narrowed a little on apical one-fifth, distinctly longer (5 : 4) than femur ; tarsus 55 : 45 : 35 : 70, first tarsal joint with 7–8 spines antero-ventrally. Hind legs, about 2·4 mm. ; coxa (5 : 4) broad and robust, with 3–4 strong parallel rugae across the hollow above the base of femur ; femur (7 : 3) one-third longer than coxa, swollen anteriorly (externally) and deep, with 7–8 strong teeth along distal half of the ventral edge (fig. 4, *c*) ; tibia (5 : 1) straight ventrally, broadly convex along dorsal edge, a little narrowed on basal third and apical fourth ; spur single, stout, flattened and deeply set ; apical posterior edge rounded, with comb of 14 spines ; tarsus 35 : 40 : 35 : 85, profile with about 7 spines ventrally on first tarsal joint. Apart from the spines mentioned above, the legs generally are extremely pilose or bristly.

Abdomen about as long as thorax. Tergites simple, band-like, visible proportions approximately 6, 3, 4, 4, 5, 5, for the most part densely set with short stiff bristles, except on the first (3rd) broadly in the middle and to hind edge, and on the second (4th) antero-medianly ; counting along the mid line antero-posteriorly the tergites bear the following decumbent rows 0, 3, 4, 6, 8, 10 ; each bristle of these rows rises from a horseshoe-shaped hollow deeper anteriorly and shallowing posteriorly. Sternites in ratio 6, 4, 4, 3, 14 ; very closely associated and forming a trapezoidal plate only three-fifths the length of the ovipositor, which is not extruded and is covered only at base ; the peculiar sculpture of the tergites is reproduced on first four sternites medianly ; basal part of the valve eight times the distal.

Length, about 3 mm. ; alar expanse, 5·2–5·5 mm.

♂. Similar to the ♀ but easily recognised by the antennae (fig. 3, *a*, *b*), longer petiole and abdomen. There are numerous minor comparative differences, *e.g.*, labrum with fewer bristles (about 14) ; forewings broader (7 : 3) ; legs rather more slender, *e.g.*, fore femur (10 : 3), hind femur (8 : 3). There are only 3–4 distinct hind femoral teeth, and in all the legs the fourth joint of the tarsus is shorter, less robust, and with weaker claws.

Antenna (fig. 3, *a*), the three ring joints are simple wedge-like laminae (fig. 3, *b*), together triangular in profile and fitted into a hollow of the first funicular joint. Joints 1–3 of funicle are much excised and contracted dorsally towards the apex from beyond one-half. Proportions (taking the length of the scape as 100), scape 100 : 32, pedicel, 30 : 21, funicle, 72 : 24, 80 : 20, 80 : 18, 48 : 16, 52 : 12.

Length, 2·1–2·4 mm. ; alar expanse 3·4–3·9 mm.

Gold Coast : Aburi, 8.xii. 1923 (*G. S. Cotterell*).

Type ♀ in the British Museum, one of a series of four ♂♂ and four ♀♀, bred from *Coelaenomenodera elaeidis*, Maul. var. Paratypes ♂ and ♀ have been deposited in the United States National Museum, Washington.

Mr. Cotterell makes the exceedingly interesting note that the ♀♀ *C. podagrica* emerged from the pupa of the host and once from the larva, while the ♂ was always bred from the host larva. Should this prove to be the general rule for this species it may be correlated with the difference in size between the sexes and the presumably longer larval life necessary for the ♀.

Closterocerus africanus, sp. n. (fig. 5).

♀. Ground-colour black or very dark sepia ; head and thorax with dark metallic refringence (violet and green) ; on the metanotum the blue-green is masked by coppery reflections, which reappear faintly over the abdomen. Antennae, femora, hind tibiae and first joint of hind tarsi dark sepia ; fore and hind tibiae mainly pale, more or less dark-streaked dorsally and ventrally ; tarsal joints (with the exception noted) pale ; 1–3 in fore and hind legs a little infuscated dorsally ; tarsal ungues like femora. In the wings (fig. 5, *a*) the darker areas and nervures are light sepia.

Head about 5 : 3 from in front. Frons at widest and base line of eyes, half the width. Sculpture of head, thorax, etc., normal for the genus.

Fig. 5. *Closterocerus africauus*, sp. n., ♀ ; (*a*) fore wing ; (*a′*) modified hairs on fore wing ; (*b*) antenna ; (*c*) ring joint.

Antenna (fig. 5, *b*, *c*) ; scape (5 : 2) longer than the pedicel and first two funicular joints together. The lengths of all the antennal joints are approximately 20, 8, 5, 6, 6, 5, 7. The average width of the funicle is 6 and of the last club joint rather under 4.

Fore wings (fig. 5, *a*, *a′*) (13 : 6) ; submarginal : marginal : radius : postmarginal, 5 : 11 : 2 : 1. Hindwings (17 : 3) very long and narrow, practically as long as the forewing.

Fore femur with 6, hind femur with 10 long bristles; hind tibial comb with 9 spines.

Length, 1·6 mm.; alar expanse, 2·6 mm.

Gold Coast: Aburi, viii. 1923 (*G. S. Cotterell*).

Type ♀ in the British Museum, one of a series of three (two broken) reared from eggs of *Coelaenomenodera elaeidis*, Maul. var.

This species is easily recognisable by the shape of the pedicel and penultimate antennal joint, and by the wing pattern.

Achrysocharis leptocerus, sp. n. (fig. 6).

♀. Blackish brown, vertex and thorax with dark green metallic reflections, abdomen at most faintly cupreous above. Wings hyaline, save for a small, very faint spot (nearly invisible in balsam but plainer on a card mount) at the end of the radius on its basal aspect. Antenna brown; scape with a dorsal pale streak from base to apex; third funicular joint mainly pale. Legs with coxae mainly (and always superiorly) brown or infuscated; femora brown-streaked above, the rest paler, with dark empodia.

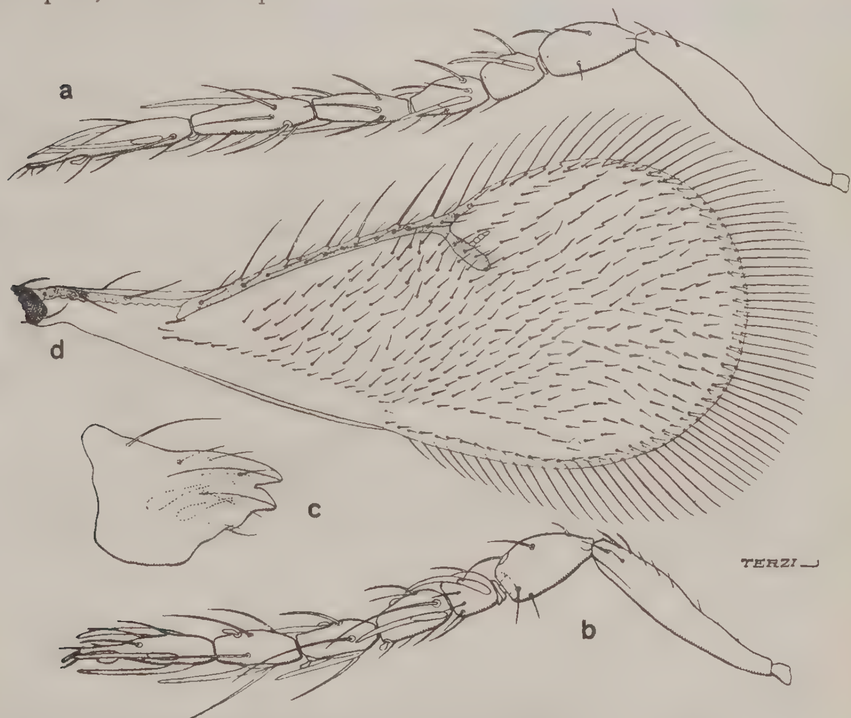

Fig. 6. *Achrysocharis leptocerus*, sp. n.; (*a*) antenna, ♂; (*b*) antenna, ♀; (*c*) mandible, ♀; (*d*) fore wing, ♀.

♂. Similar to ♀, but the antennal club is darker and the third funicular joint not markedly different in colour from the others.

♀. Head, from above, much broader than long (8 : 5), about one-third broader than thorax or abdomen, broadly parabolic in outline—the parabola somewhat

flattened in front, and only slightly concave medianly below the rounded occipital margin. The whole vertical aspect much flattened; occiput well developed behind but narrower than the eyes. The latter bare, four-fifths as long as the head. Vertex broad, nowhere less than one-half the width across the eyes. Ocellar triangle obtuse; anterior ocellus circular, posterior elliptical, rather over their length from the orbit and about four times their length from the occiput. Whole upper surface coriaceous. In profile the head is subtriangular.

Antenna (fig. 6, *b*), length 0·44 mm., over half as long as the body, scape (5 : 1) two and a half times as long as the pedicel, or a little longer than pedicel, ring joints and first two funicular joints together, or equal to the second to the fourth funicular joints together, or four and a half times as long as the first funicular joint. The greatest width (depth) of the antenna is on the pedicel ($12\frac{1}{2}$). Joints of funicle and club in ratio 12 : 15 : 19 : 20 : 33 with breadths 10 : 9 : 8 : 7 : 6. The "beak" of the club occupies rather over one-third of the length, and at its base there is a remarkable curved sense-organ. The surface of the antennal joints is longitudinally rugulose striate—seen well in pedicel.

Mandibles (4 : 3) similar, apically bidentate (fig. 6, *c*). Maxillary palp (about 3 : 1) with terminal bristle one and a half times as long as the palp. Labial palp very minute, two-fifths the length of the maxillary palp, and about as broad as long; terminal bristle four times the palp.

Thorax flat, entire notal surface with strongly raised pattern of rather large regular cells; parapsidal furrows on posterior two-thirds smoother. There are few bristles; on pronotum the posterior row is apparently of six (3 : 3); parapsides and axillae bare (?); scutum 1 : 1 (just behind one-half); scutellum 1 : 1 (behind one-half).

Propodeon simple, transverse, nearly smooth in middle but rougher (with a few rugae) towards the sides. Spiracles small, oval, median (antero-posteriorly), outwardly directed. Separated by three-fourths the width of the sclerite or by rather more than the width of the scutellum. One bristle outside each spiracle and one below on metepimeron.

Fore wings (fig. 6, *d*) (17 : 7) length 0·53 mm., breadth 0·23 mm. Submarginal : marginal : radius : postmarginal, 15 : 27 : 7 : 4. Longest cilia of fringe one-third the breadth of wing. Hind wings (8 : 1), length 0·5 mm., breadth 0·06 mm.; longest cilia 0·08 mm.

Legs with the coxae rather slender, about 2 : 1 in fore and hind legs and rather broader (7 : 4) in hind pair. The fore pair have a large and distinct pattern, not strongly raised, the others are nearly smooth. Fore legs, femur (13 : 3) with (as in all the legs) a strong hyaline preapical ventral bristle, tibia (15 : 2); mid legs, femur (5 : 1), tibia (11 : 1); hind legs, femur (3 : 1) with five rather long bristles in postero-ventral row—not quite on edge.

Tarsus	1		2		3		4
i	10	...	10	...	10	...	16
ii	13	...	11	...	11	...	18
iii	11	...	11	...	11	...	17

Abdomen longer than thorax and propodeon, with practically smooth tergites.

♂. Antenna (fig. 6 *a*) 0·5 mm., slightly longer and more slender than in the ♀. Scape (5 : 1) two and a half times as long as pedicel (2 : 1) and just longer than pedicel and first two funicular joints together, or than the first three funicular joints. Funicle and club approximately 5 : 6 : 7 : 9 : 12. Breadth from scape to first funicular about four, afterwards diminishing gradually to about two on club.

Forewings (8 : 3) slightly broader than in ♀.

Length, ♀, ♂, about 0·7 mm. ; alar expanse, ♀, ♂, about 1·2 mm.

GOLD COAST : Aburi, 8.xii.1923 (*G. S. Cotterell*).

Type ♀ in the British Museum, one of a series of one ♂, two ♀♀, bred from eggs of *Coelaenomenodera elaeidis*, Maul. var.

Pleurotropis nigripes, Waterst.

Pleurotropis nigripes, Waterston, Bull. Ent. Res. v, March 1915, p. 353.

Besides the species just recorded, Mr. Cotterell reared a number of hyperparasites of the genus *Pleurotropis* and referable, for the most part, to the above species.

Mr. Cotterell's material was in two lots : (*a*), noted as a hyperparasite on *Cotterellia podagrica* ♂, ♀ ; and (*b*), noted as a hyperparasite on *Dimmockia aburiana* ♂, ♀. In the tube containing the ♂ of *D. aburiana* were three ♀ of *P. nigripes* apparently included as being the same thing. The specimens in (*a*) are all *nigripes*, and so is the greater part of (*b*), but this lot contains also several specimens in which the scutellum is completely reticulated. Consideration of the latter examples must for the present be deferred.

R. nigripes, Waterst., was originally described as bred with *Eurytoma* sp. from Braconid cocoons in Southern Nigeria (*l. c.* p. 355).

COLLECTIONS RECEIVED.

The following collections were received by the Imperial Bureau of Entomology, between 1st October and 31st December, 1924, and the thanks of the Managing Committee are tendered to the contributors for their kind assistance :—

Dr. J. S. Armstrong :—44 Diptera, 71 Coleoptera, 65 Hymenoptera, 136 Lepidoptera, 71 Rhynchota, 8 Orthoptera, and 4 Planipennia ; from Samoa.

Prof. H. A. Ballou :—2 Chalcididae, 5 Lepidoptera, and 43 Rhynchota and early stages ; from Trinidad.

Dr. C. F. C. Beeson, Forest Zoologist :—188 Curculionidae ; from Dehra Dun, India.

Mr. J. Bei-Bienko :—33 Coleoptera, 7 Rhynchota, and 67 Orthoptera ; from Siberia.

Mr. Ll. E. W. Bevan :—5 Asilidae ; from Southern Rhodesia.

Mr. G. E. Bodkin, Government Entomologist, Department of Agriculture :— 10 Diptera, 36 Hymenoptera, 2 Lepidoptera, 3 Rhynchota, and 265 Ticks ; from Palestine.

Dr. H. S. de Boer :—98 Culicidae ; from Kenya Colony.

Dr. G. Bondar :—55 Coleoptera, 85 Chalcididae, and a number of Mites ; from Brazil.

Mr. J. R. Bovell, Superintendent of Agriculture :—7 Coleoptera ; from Barbados.

Mr. J. H. Burkill :— 1 species of Coccidae ; from Singapore.

Dr. P. A. Buxton :—51 Culicidae, 2 Tabanidae, 20 Nycteribiidae, 428 other Diptera, 670 Coleoptera, 441 Hymenoptera, 709 Lepidoptera, 19 species of Coccidae, 2 species of Aleurodidae, 2 species of Aphididae, 345 other Rynchota, 110 Orthoptera, 16 Planipennia, 39 Odonata, 4 Collembola, 5 Mallophaga, 43 Ticks, 5 Mites, 100 Spiders, 8 Scorpions, and 4 Pseudo-scorpions ; from Samoa.

Mr. E. C. Chubb :—228 Orthoptera ; from Natal.

Mr. L. D. Cleare, Junr., Government Economic Biologist :—4 Culicidae, 6 other Diptera, 2 Lepidoptera, and 8 species of Aphididae ; from British Guiana.

Dr. A. Connal :—5 Mites ; from Lagos, West Africa.

Mr. H. H. Curson :—13 Diptera, 124 Coleoptera, 22 Hymenoptera, 138 Lepidoptera, 27 Rhynchota, 43 Orthoptera, 5 Planipennia, 6 Odonata, 7 Spiders, and 16 Snails; from South Africa.

Director of Agriculture, Gambia :—11 Diptera and 2 pupae, 14 Coleoptera, 11 Lepidopterous cocoons, and 4 Rhynchota nymphs ; from the Gambia.

Division of Entomology, Pretoria :—199 Coleoptera, 14 Hymenoptera, 52 Rhynchota, 2 Orthoptera, and 2 *Bittacus* ; from South Africa.

Mr. P. R. Dupont :—59 Formicidae and 4 species of Coccidae ; from Seychelles

Dr. H. Silvester Evans :—756 Coleoptera ; from Fiji Islands.

Dr. D. T. Fullaway :—22 Coleoptera ; from the Panama Canal Zone.

Mr. A. Gibson :—1 species of Coccidae ; from British Colombia.

Mr. F. D. Golding :—8 Diptera, 54 Coleoptera, 20 Chalcididae, 12 Formicidae, 11 Lepidoptera and 3 pupa-cases, 32 Rhynchota, 4 Orthoptera, and 2 Hemerobiidae ; from Southern Nigeria.

Mr. C. C. Gowdey, Government Entomologist :—17 Culicidae, 5 other Diptera, 9 Coleoptera, 12 Lepidoptera, 4 species of Coccidae, and 2 species of Aphididae ; from Jamaica.

Mr. C. B. HARDENBERG :—1,195 Coleoptera ; from Portuguese East Africa and South Africa.

Mr. E. HARGREAVES, Government Entomologist :—49 Culicidae, 29 Tabanidae, 61 *Glossina*, 21 Simuliidae, 133 other Diptera, 498 Coleoptera, 70 Chalcididae, 29 other Hymenoptera, 6 Lepidoptera, 30 Thysanoptera, 48 species of Coccidae, 195 other Rhynchota and 5 nymphs, 51 Orthoptera, and 4 Trichoptera ; from Sierra Leone.

Mr. H. HARGREAVES, Government Entomologist :—14 Tabanidae, 23 *Glossina*, 4 Hippoboscidae, 371 other Diptera, 461 Coleoptera, 200 Parasitic Hymenoptera, 4 other Hymenoptera, 48 Lepidoptera, 9 species of Coccidae, 12 other Rhynchota, 2 Orthoptera, 3 Ephemeridae, and 3 Chrysopidae ; from Uganda.

Dr. W. HORN :—612 Curculionidae ; from Asia.

Mr. M. AFZAL HUSSAIN, Government Entomologist :—135 Siphonaptera, 2 Diptera, 15 Lepidoptera and 3 pupa-cases, 2 Rhynchota, 8 Orthoptera, 6 Ticks, 10 Mites, and 4 tubes of Intestinal Worms ; from Punjab, India.

Mr. E. JACOBSON :—2 *Tabanus*, 2 *Chrysops*, 25 other Diptera, and 320 Coleoptera ; from Sumatra.

Mr. E. JARVIS :—2 Coleoptera and 11 larvae ; from Queensland, Australia.

Mr. L. G. E. KALSHOVEN, Forest Entomologist :—103 Curculionidae and 4 larvae ; from Java.

Mr. S. KELER :—10 Diptera, 449 Parasitic Hymenoptera, 3 other Hymenoptera, and 8 Lepidoptera ; from Poland.

Mr. NORMAN E. LAMONT :—4 Coleoptera ; from Brazil.

Mr. E. W. LANNIN :—2 Lepidoptera ; from Southern Rhodesia.

Mr. M. E. MACGREGOR :—12 Coleoptera ; from Portugal.

Mr. G. A. MAVROMOUSTAKIS :—13 Diptera, 61 Coleoptera, 110 Hymenoptera, 2 Rhynchota and 3 nymphs, and 96 Orthoptera ; from Cyprus.

Mr. N. C. E. MILLER :—278 Orthoptera ; from Tanganyika Territory.

NATIONAL MUSEUM, MELBOURNE :—11 Culicidae, 7 other Diptera, 59 Rhynchota, and 9 Embiidae ; from Australia.

Mr. V. V. NIKOLSKY :—10 Culicidae and 2 *Phlebotomus* ; from Russia.

Prof. G. H. F. NUTTALL, F.R.S. :—4 Culicidae, 66 Tabanidae, 6 Hippoboscidae, and 36 other Diptera ; from Punjab, India.

Mr. L. OGILVIE, Plant Pathologist :—2 *Tabanus*, 141 other Diptera and 2 pupa-cases, 77 Coleoptera and 2 larvae, 26 Chalcididae, 80 other Hymenoptera, 10 Lepidoptera and 4 larvae, 3 Isoptera, 36 Thysanoptera, 3 species of Coccidae, 4 species of Aphididae, 15 other Rhynchota, 8 Orthoptera, and 4 Spiders ; from Bermuda.

Mr. A. W. J. POMEROY, Government Entomologist :—9 Parasitic Hymenoptera, 12 Lepidoptera and 3 pupa-cases, and 37 Rhynchota ; from Southern Nigeria.

Mr. A. H. RITCHIE, Government Entomologist :—6 Tabanidae, 2 other Diptera and 2 pupa-cases, 395 Coleoptera and 27 early stages, 2 Hymenoptera, 13 Lepidoptera and 2 pupae, 165 Thysanoptera, 2 species of Coccidae, 46 other Rhynchota, 6 Orthoptera, and 8 Planipennia ; from Tanganyika Territory.

Mr. H. W. SIMMONDS, Government Entomologist :—8 Diptera, 23 Coleoptera, 27 Parasitic Hymenoptera, 19 other Hymenoptera, 13 Lepidoptera, 5 Thysanoptera, 9 species of Coccidae, 5 other Rhynchota, and 6 Orthoptera ; from Fiji Islands.

Mr. H. J. SNELL :—4 Tabanidae, 216 other Diptera, 116 Coleoptera, 292 Hymenoptera, 2 Thysanoptera, 77 Rhynchota, 4 Orthoptera, 25 Odonata, and 2 Trombidiidae ; from Zanzibar.

Dr. V. G. L. VAN SOMEREN :—5,700 Culicidae ; from Uganda.

Station Entomologique, Paris :—20 Orthoptera ; from French Senegal.

Mr. O. Theodor :—5 Tabanidae, 5 *Simulium*, 13 other Diptera. 59 Coleoptera, 17 Hymenoptera, 2 Rhynchota, and 8 Orthoptera ; from Palestine.

Mr. H. P. Thomasset :—26 Culicidae, 2 Tabanidae, 193 other Diptera, 94 Coleoptera, 28 Hymenoptera, 184 Lepidoptera, 22 Orthoptera, 10 Trichoptera, 4 Ephemeridae, and 3 Thysanura ; from Natal.

Dr. W. R. Thompson :—9 Lepidoptera ; from France.

Dr. R. J. Tillyard :—7 Thysanoptera ; from New Zealand.

United States National Museum, Washington :—11 Curculionidae ; from Haiti, West Indies.

Mr. F. W. Urich :—2 Lepidoptera, 2 species of Aphididae, and 10 other Rhynchota ; from Trinidad.

Mr. R. Veitch :—3 Coleoptera, 5 Chalcididae, and 3 Lepidoptera ; from Fiji Islands.

Prof. J. Wagner :—140 Orthoptera ; from Jugo-Slavia.

Wellcome Tropical Research Laboratories, Khartoum :—60 Chalcididae, 80 Thysanoptera, 46 Rhynchota, and 478 Orthoptera ; from British Sudan.

Mr. D. S. Wilkinson, Government Entomologist :—6 Diptera, 15 Coleoptera, 10 Chalcididae, 10 Lepidoptera, and 8 Rhynchota ; from Cyprus.

Miss F. M. Wimshurst :—48 Parasitic Hymenoptera, 7 Aphididae, 4 other Rhynchota, and 2 Spiders ; from Brenchley, Kent.

Zoologisches Museum, Berlin :—99 Orthoptera ; from Germany.

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